FOREST PEST REPORT 1991

by
The Forest Insect and Disease Unit
Minnesota Department of Natural Resources
Division of Forestry
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THE FOREST HEALTH UNIT

FOREST INSECT AND DISEASE MANAGEMENT PROGRAM

There are approximately 16.5 million acres of forest land within the State of Minnesota. Over one-half of the commercial forest land is publicly owned. These forests support a 2 billion dollar forest industry, which is the third largest industry within the state. The Minnesota Department of Natural Resources (MN-DNR) has been charged by the legislature with providing management efforts and/or support on Minnesota's state, county, and private forest lands.

The Forest Health Unit is contained within the Forest Management Section of the MN-DNR Forestry Division and is charged with managing Minnesota's forest and tree resources to reduce the impacts of insects, diseases, and other pests. The supervisor of the Forest Health Unit is located in the St. Paul Central Office, while field activities are coordinated and implemented within six regional administrative units. The Forest Health Unit Supervisor is S. Olin Phillips, and Regional personnel are:

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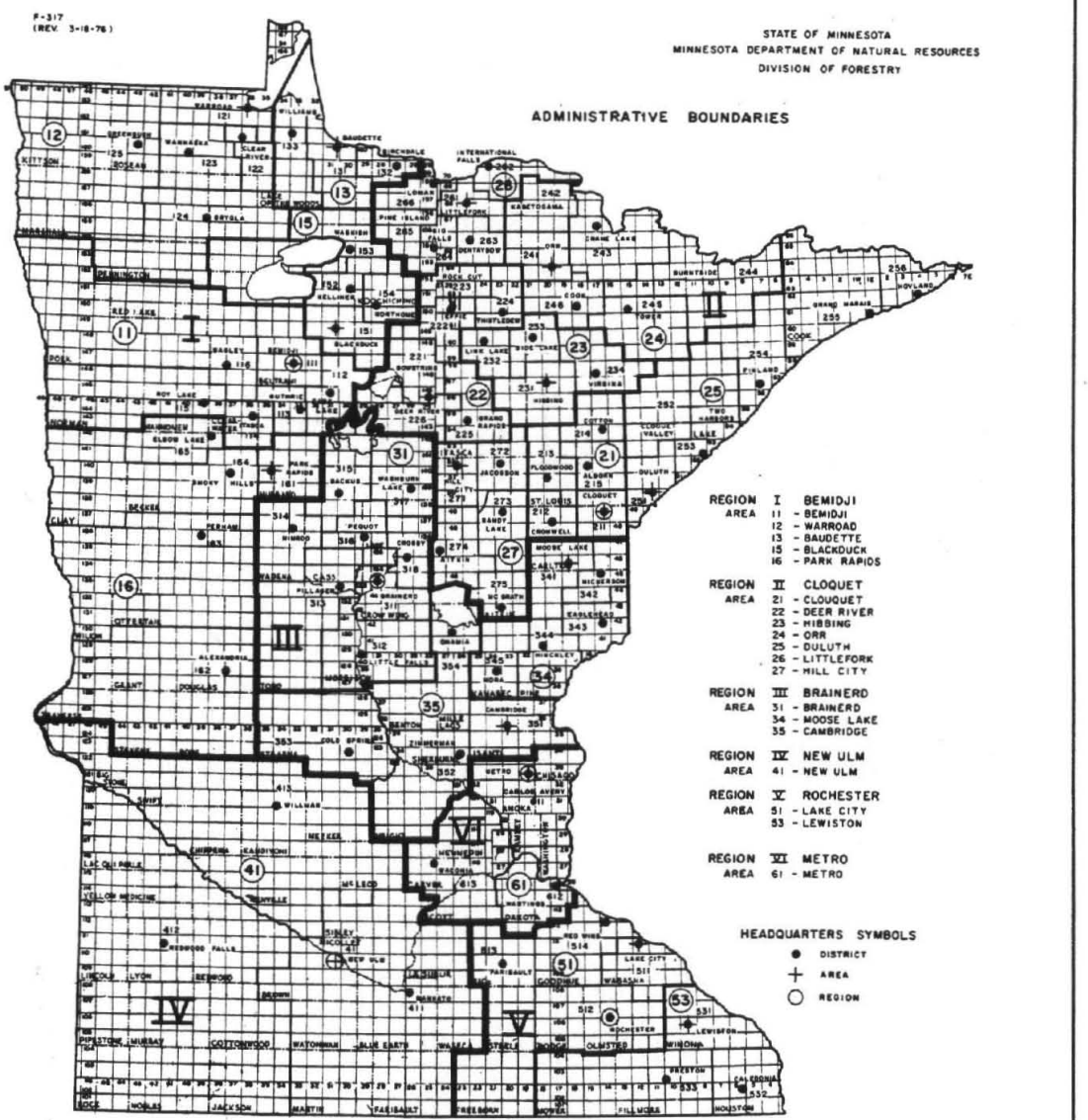

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PEST CONDITIONS REPORT

INSECTS

- ✔ JACK PINE BUDWORM
- ✔ PINE TUSSOCK MOTH
- ✔ JACK PINE SAWFLY
- ✔ INTRODUCED PINE SAWFLY
- ✔ WHITE PINE SAWFLY
- ✔ BARK BEETLES
- ✔ PINE SPITTLEBUG
- ✔ SPRUCE BUDWORM
- ✔ YELLOWHEADED SPRUCE SAWFLY
- ✔ WHITE SPRUCE CONE INSECTS
- ✔ CEDAR LEAF MINERS
- ✔ GYPSY MOTH
- ✔ FOREST TENT CATERPILLAR
- ✔ ASPEN WEBWORMS AND LEAFROLLERS
- ✔ TWO-LINED CHESTNUT BORER
- ✔ BRONZE POPLAR BORER

JACK PINE BUDWORM

Choristoneura pinus Freeman

ACREAGE: 560

SEVERITY: Moderate to heavy defoliation: 20-50%+ needle loss

TREND: The last major jack pine budworm infestation occurred between 1984 and 1988. Peak defoliation years was 1987 when 100,000 acres were defoliated and 1988 when 300 acres were defoliated. In 1989 no budworm activity was found. In 1990, light defoliation was observed on 300 acres, primarily in Region 1. In 1991, defoliation in Region 1 only amounted to 60 acres, but in Pine County in Region 3, defoliation increased to 500 acres.

SURVEY: General detection surveys as well as larval and egg mass surveys were conducted on 3.1 million acres. Survey counts and locations can be found in the SURVEY RESULTS section.

REGIONAL NOTES

REGION 1

Early larval surveys indicated that the JPBW was for real in Region 1. In 1990 defoliation was first noticed after the population collapse between 1987 and 1988. Larvae and egg masses were also found. The area of greatest activity was west of Bemidji in Beltrami County.

In 1991 larval surveys in early June confirmed the presence of JPBW in larger numbers than were found in 1990. The survey method at this time

of the year is to collect 30 shoots from 6 different trees and count the number of shoots with larvae. Some plots west of Bemidji had 6 to 17 shoots averaging 13 with larvae and all 30 shoots showed evidence of being chewed by the budworm. From these results, heavy defoliation was expected. However, defoliation was very light and no egg masses could be found.

A new area of moderate defoliation (20-50% needle loss) was found in Hubbard County, S3&4-T143N-R34W. About 60 acres of mature jack pine were affected. Branches had chewed needles and pupal cases were evident. No egg masses, however, were found in this area or in adjacent stands

REGION 3

Budworm activity in this Region increased in both acreage and intensity. Last year only very light defoliation could be detected in 1 township in Pine County. In 1991, there were 500 acres in 3 townships in this County that experienced moderate to heavy defoliation (20-50% needle loss).

A small, and potentially damaging population appears to be building in Pine County. Heavy defoliation occurred in S25&36-T45N-R20W, and in S6-T44N-R19W. This is the second year of defoliation in section 36. The trees still have live buds in their uppermost crowns but needles are sparse. Unfortunately this is also the area where pine sawflies caused defoliation of older needles on the same trees and was part of the area hit by the March 22nd ice storm.

Very small populations of budworm occurred in Cass, Crow Wing and Wadena Counties as evidenced by moth catches in pine tussock moth traps. Defoliation, however, is not great enough in these counties to be readily detectable.

PHENOLOGICAL NOTES

MAY

14 Jack pine candle 1-3" long: Cass/Crow Wing Cos.
21 Jack pine shedding pollen: Pine Co.

JUNE

6 Jack pine candles elongated; no needle development: Pine Co.
7-10 Larvae in 5th instar; feeding in staminate cone clusters: Pine Co.
11 6 & 7th instar larvae feeding on needles; needle browning visible: Pine Co.
18 40% pupated: Pine Co.

JULY

2 80% moths, 18% pupae and 2% larvae: Pine Co.
11 Moth flight completed: Pine Co.

PINE TUSSOCK MOTH

Dasychira pinicola (Dyar)

ACREAGE: None

SEVERITY: Defoliation not detectable.

TREND: In 1980, 2 townships were heavily defoliated in Pine Co. Since that time, populations have remained low.

SURVEY: General detection surveys and pheromone trapping occurred on 1,884,000 acres. Survey details can be found in the SURVEY RESULTS section.

REGIONAL NOTES

REGION 3

In 1991, pheromone trap catches were up slightly, ranging from 12-48 moths and averaging 34 moths per trap. Pine tussock moths were trapped from an area of about 92,000 acres located in 2 townships in Pine County, 1 township in Wadena County, and 1 township in Crow Wing County. However, no defoliation could be seen in this area. Despite the increased trap catches, continued low populations are expected in 1992.

PHENOLOGICAL NOTES

MAY
14 Jack pine candles 1-3 " long: Cass/Crow Wing Cos.
21 Jack pine shedding pollen: Pine Co.

JUNE
6 Jack pine candles elongated; no needle development: Pine Co.
26 Collected larvae: Pine Co.

JULY
30 Peak moth catch: Regionwide.

JACK PINE SAWFLY

Neodiprion pratti banksianae Rohwer

ACREAGE: 7,000+ acres. There was an estimated 7,000 acres of defoliation in southeastern Koochiching Co. An additional undetermined acreage existed throughout the rest of Koochiching, St Louis, Itasca Southern Beltrami, Hubbard, Cass, Crow Wing, Wadena, and Pine Counties.

SEVERITY: Moderate defoliation or 20 - 50% needle loss was the general, overall rating. However, heavy defoliation or greater than 50% needle loss occurred on approximately 20% of the trees.

TREND: This is a commonly occurring defoliator in pine areas in central and northern Minnesota. It usually does not occur in heavy enough numbers to cause significant defoliation. However, in 1990 in Koochiching County, defoliation intensity was similar to that occurring during 1991. Defoliation in the other counties was not evident in 1990. Ontario and Wisconsin also reported an increase in sawfly defoliation during 1991.

REGIONAL NOTES

REGION 1

In early to mid-June, numerous calls were received from landowners in southern Beltrami and northern Hubbard Counties regarding pine defoliation. This sawfly was observed feeding on large jack pines and was causing noticeable defoliation. Individual trees rather than stands were defoliated. For people who had large jack pines close to their homes where defoliation could readily be observed, the problem was primarily an aesthetic problem. It is not anticipated that this sawfly will be a major problem in this Region.

REGION 2

Jack pine sawfly defoliation became evident in early June. The most concentrated area of defoliation was in southeastern Koochiching County in T65N-R23W, T65N-R24W, T66N- R26W, T66N-R27W, T64N-R22W, and T65N-R22W where approximately 7,000 acres were defoliated. More scattered defoliation occurred in other parts of Koochiching County, and in Itasca and St Louis Counties.

There are a number of sawflies that feed on jack pine. Positive identification of the sawfly was based on the appearance of the larvae and the oviposition scar. The discolored scar around the egg in the jack pine needle was most visible on the flat side of the needle.

Jack pine sawfly is normally not considered a cause of mortality because the larvae feed on older foliage and leave the current year foliage on the tree. Also, most outbreaks don't last more than 2-3 years. Unless the trees are overmature and under stress from other factors such as drought, tree mortality does not normally occur. Many of the affected trees in southeastern Koochiching Co. are over mature and are under drought stress. While the drought ended in most of Region 2 in 1989, it continued through most of the summer of 1990 in Koochiching County. However, the jack pine produced good shoot and needle growth during the summer and significant mortality is not expected in 1992.

No method exists to predict next year's sawfly population or level of defoliation in Minnesota. A study was begun to develop egg survey methodology. Details of that study are can be found in the SPECIAL PROJECTS section of this report. The report is titled, "Development of a Jack Pine Sawfly Egg Survey."

REGION 3

The acreage of defoliation in the Region was not determined, but defoliation was observed in Cass, Crow Wing, Pine, and Wadena Counties. Defoliation, however, was very light to moderate and occurred only on the older needles. Jack pine stands in Wadena County look better than they have the past 2 years.

Generally, populations have been building since 1989. Sawflies were common last year in the central and northern counties, but they appear to have increased in intensity compared to last year.

PHENOLOGICAL NOTES

MAY

14 Eggs have hatched and small larvae are feeding on needles: Koochiching Co.

JUNE

5 Larvae 5/8" long: Crow Wing Co.

10 Larvae are 1/2 to 1 inch long: Koochiching Co.

12 Larvae 3/4" long and nearly finished feeding for the season: Crow Wing Co.

14 100% of larvae in cocoons. Crow Wing Co.

AUGUST

9 Pupae collected from duff layer beneath defoliated trees: Koochiching Co.

16 Several adult JP sawflies emerged in lab from collected pupae.

INTRODUCED PINE SAWFLY

Diprion similis (Hartig)

ACREAGE: The acreage was not determined, but sawflies were found in Itasca, St. Louis, Cass, Crow Wing, and Morrison Counties; and several in several counties in southwestern Minnesota.

SEVERITY: Moderate defoliation was observed in Itasca and St. Louis Counties, but in counties in Region 3 defoliation was very light to light (<20%).

Trend: There have been a few sporadic reports in past years, but no major outbreaks.

REGIONAL NOTES

Region 2

Light to moderate levels of defoliation were observed in late summer in Itasca and St Louis Counties.

REGION 3

Sawfly feeding was observed in Cass, Crow Wing, and Morrison Counties. Defoliation was very light to light, and falling frass was more noticeable than the defoliation. It was this falling frass that was reported by many private landowners. No sawfly larvae were found during July as they have been in past years. Populations were very low, and there were 2 generations of the introduced pine sawfly this year.

REGION 5

Individual white pines were reported being defoliated during September in several southwestern counties.

PHENOLOGICAL NOTES

AUGUST

3 Defoliation evident: Itasca Co.

12 1st generation larvae, 7/16" to 1 and 1/16" long; cocoons rare: Crow Wing Co.

15 1st generation larvae, 1 and 3/8" long; 2 cocoons found; 2nd generation larvae, 5/16" long; no noticeable defoliation: Morrison Co.

19 Defoliation of mature white pines is noticeable: Crow Wing Co.

BARK BEETLES

Ips spp.

ACREAGE: Actual acreage of bark beetle infestations were not determined. In Pine County an early spring ice storm damaged 4,300 acres of red and jack pines. These areas were of particular concern for developing bark beetle populations. On 250 acres of high value red pine plantations, bark beetle pheromone traps were placed to prevent damage to surviving pine.

SEVERITY: Tree mortality occurred to scattered individual trees and to small pockets of trees. A damaging population of bark beetles did not occur.

TREND: Bark beetle activity peaked during the drought years of 1987-89. Bark beetles continue to be a problem where fresh slash and debris are present during the growing season, and in areas where drought conditions continue to linger. Generally, bark beetle activity is waning.

REGIONAL NOTES

REGION 1

On June 6 bark beetle adults were found in slash piles of jack pine in the Northome District in Itasca County. All stages of beetle development were present, but pupae and adults were more common than larvae. Burning of the slash piles to eradicate bark beetle brood before major adult emergence occurred was scheduled for the week of June 10th.

REGION 2

In Koochiching County, scattered pockets of jack pine died from drought and bark beetle attacks. Especially hard hit was an area east of Big Falls. Most of the mortality appeared to have occurred in 1990. Beetles were active in 1991 but little additional mortality was noted.

Some of the pockets of mortality contained up to 50 dead trees. Bark beetle pockets were most commonly seen along the edge of stands especially where there had been some logging activity in the past several years. Along some roads, up to 6 pockets per mile were observed in this area.

Bark beetle activity and damage were also observed in mature red pine on an island in Lake Vermillion. The primary problems were drought and the abundance of pine logs and slash laying among the trees. The logs and slash were due to storm damage, and road and powerline construction.

REGION 3

In Pine and Aitkin Counties, 4,300 acres of pine were damaged during an ice storm on March 22. In some of the damaged areas, 10-50% of slash and snags were infested. "Operation Ice Storm" was instituted to reduce fire and bark beetle hazards. Bark beetle hazards were reduced by following of the Divisions's guidelines for managing bark beetles and the placement of pheromone traps. A damaging population of bark beetles did not develop; they only attacked slash and snags. In fact, as much as 50% of this material was left unutilized by August 14th.

There were 3 levels of bark beetle activity. On 7 of 11 sites, slash and snags were colonized only in May by beetles emerging from the duff. No brood development was evident. On 2 sites, first generation brood was produced. On the other 2 sites, there were 3 instances where both first and second generations were produced.

For a more detailed account, see the SPECIAL PROJECTS Section. The report is titled, "Ice Storm Damage of March 22nd and Bark Beetles."

On 3 sites totalling 10 acres in Aitkin County, bark beetles attacked storm damaged red pines and built up on slash and snags. Control operations did not go as planned, and there were 2 generations of bark beetles. It is suspected that a significant overwintering population will emerge next spring; so, pheromone traps were recommended for these sites in 1992.

There was a small bark beetle infestation in the red pine seed orchard in Pine County in the Eaglehead District. The bark beetle attack was triggered by thinning during April. Most of the slash was chipped, but the few trees that were not chipped were infested by bark beetles. The stems were then

burned to control bark beetle emergence. Most adult beetles had already emerged, and 12 trees turned red in June. Subsequent attacks were not successful as evidenced by the presence of resin pitch tubes on nearby trees. It was a transient infestation, but because of the value of the orchard, pheromone traps were recommend for use during the 1992 growing season. The pheromone traps would be used to both monitor a population build up and to control a possible outbreak.

REGION 6

A few isolated pockets of bark beetles were still persisting in Anoka County. These areas generally had deep sands and were severely affected by the 1987-1989 drought. Most of the bark beetle attacks were confined to Scots pine.

PHENOLOGICAL NOTES

MAY

14 Jack pine: adults constructing galleries: Koochiching Co.

21 Adults constructing galleries; some eggs hatched; larvae present: Itasca Co.
Jack pine: egg laying galleries, 2-3" long; egg niches evident: Pine Co.
Red pine: egg laying galleries, 5-6" long; larvae present: Pine Co.

JUNE

6 Adults in logging slash: Itasca Co.

7 1st generation mostly pupating; callow adults and larvae present: Itasca Co.

18 1st generation callow adults present; burning brush piles for control: Pine Co.

JULY

30 2nd generation adults laying eggs; galleries, 1-1/2" long: Pine Co.
2nd generation pupae and callow adults present: Pine Co.
BB exit holes and wood borers present: Pine Co.
Pheromone traps catching many metallic wood borers: Pine Co.

PINE SPITTLEBUG

Aphrophora parallela (Say)

REGIONAL NOTES

REGION 3

There was 1 observation of heavy damage to three, 15-feet tall jack pines located in S3-T136N-R29W in Crow Wing Co.

Adult pine spittlebugs were also observed feeding in S25-T45N-R20W in Pine County.

PHENOLOGICAL NOTES

JUNE

5 Heavy damage observed: Crow Wing Co.

JULY

2 Adults present: Pine Co.

SPRUCE BUDWORM

Choristoneura fumiferana (Clemens)

ACREAGE: 108,000 (See Map 1.)

SEVERITY: 1-20% needle loss: light defoliation on 76,500 acres
20-50% needle loss: moderate defoliation on 45,000 acres
51-100% needle loss: heavy defoliation on 27,000 acres

TREND: Populations peaked in 1986 with 440,000 acres of defoliation and have declined since. In 1990 defoliation occurred on 198,000 acres. Defoliation in most of Cook County was heavy in 1990. Defoliation in eastern Cook Co. remained heavy but declined to light in the western part of the county in 1991. Spruce budworm activity is expected to remain concentrated in Cook County with a possible decline in the western part of the county.

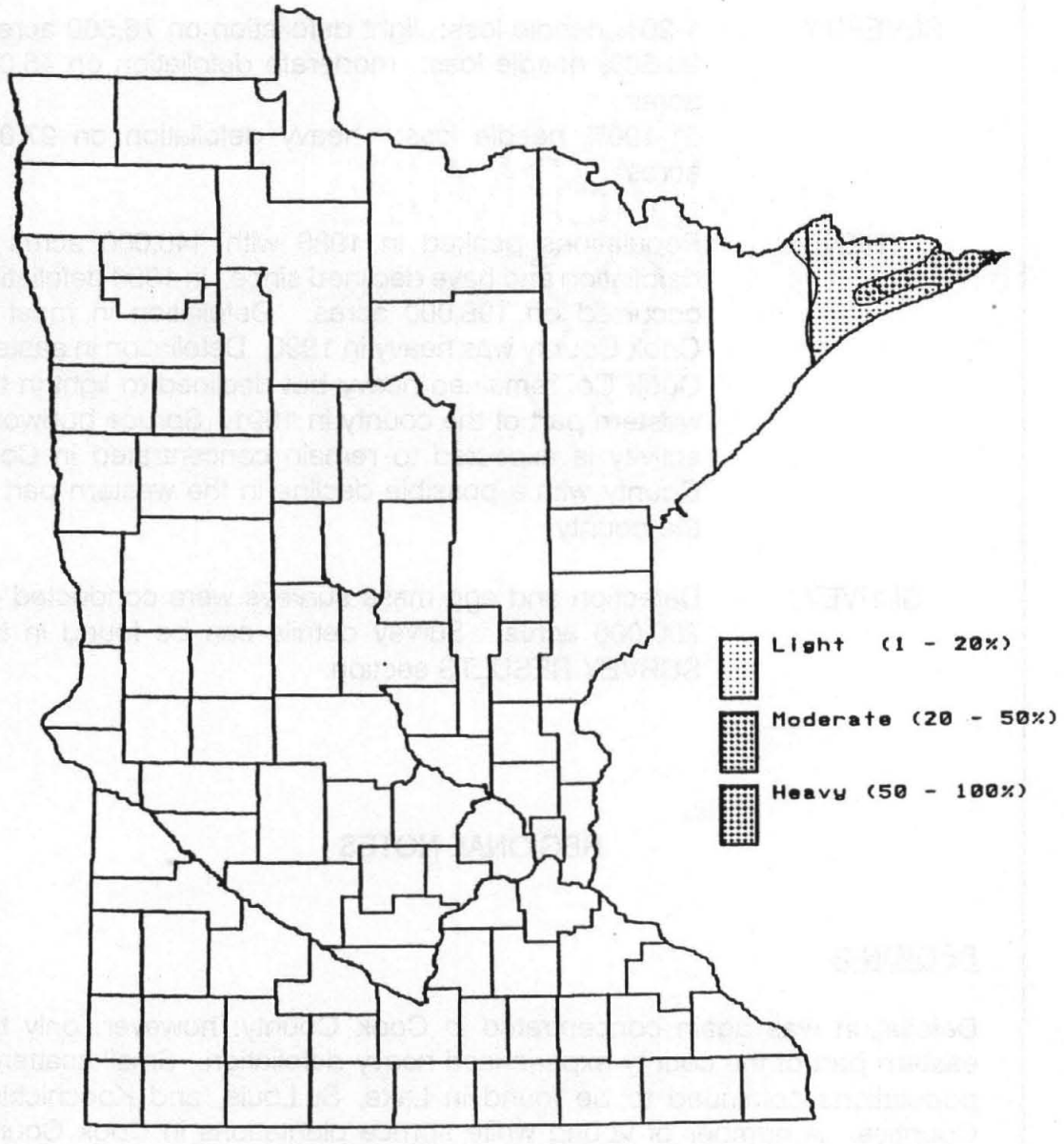
SURVEY: Detection and egg mass surveys were conducted on 700,000 acres. Survey details can be found in the SURVEY RESULTS section.

REGIONAL NOTES

REGION 2

Defoliation was again concentrated in Cook County; however, only the eastern part of the county experienced heavy defoliation. Small scattered populations continued to be found in Lake, St Louis, and Koochiching Counties. A number of young white spruce plantations in Cook County suffered heavy defoliation and may require treatment in 1992 to prevent mortality.

Map 1. Spruce Budworm Defoliation: 1991.



Pheromone trapping was again carried out in the Cook County. Average trap catches at the Jackson Lake Road site (S12-T63N-R4E) were 139, at the Jackson Lake Plantation (S35-T64N-R4E) catches averaged 468, and at the Devilfish Lake site (S32-T64N-R3W) trap catches averaged 142 moths. Defoliation at all three sites was heavy. Most of the balsam fir on the Jackson Lake Road and Devilfish Lake sites is now dead.

Egg mass surveys were conducted in and around white spruce plantations being considered for spraying. On each egg mass plot 3 branches (15 inches long) were clipped from mid-crown from each of 3 dominant or co-dominant balsam fir trees. Egg mass plots were located in balsam fir trees along the edge of the plantations or in the plantation using overstory balsam firs.

Expected defoliation in 1992 is based on the average number of egg masses per branch. No defoliation to light defoliation is predicted based on an average egg mass count of 0-0.1, moderate defoliation based on an average count of 0.1-1.7 egg masses, and heavy defoliation is based on an average count of 1.8+ egg masses.

A summary of the survey and predictions follow. (A more detailed summary is included in the SURVEY RESULTS section.)

PLANT #	DESCRIPTION	AC	YR PLANT	AVG # EM	PREDICTED DEFOL
426-25	S34-T64N-R4E	62	1974	3.7	HEAVY
337-35 337-25A	S28-T64N-R4E S34-T64N-R4E	77	1970 1971	1.6	MODERATE
445-25	S02-T63N-R4E S35-T64N-R4E	94	1975 1976	1.1	MODERATE
356-26	S11-T63N-R1E	17	1971	1.4	MODERATE
355-25	S14-T63N-R1E S15-T63N-R1E	31	1971	1.58	MODERATE

PHENOLOGICAL NOTES

MAY

23 Larvae 1/4 to 3/8 inch long: St. Louis Co.

JUNE

6 5th instar: St Louis Co.

12 100% pupated; some pupae green, most dark; few moths emerged: St. Louis Co.
100% pupated; some moths emerged: Koochiching Co.

17 100% pupated; no moths or larvae found: Lake Co.
35% pupae; 65% larvae; Bakers Lake, Sawbill Trail: Cook Co.
55% larvae; 45% pupae; near Gust Lake, Sawbill Trail: Cook Co.
70% pupae; 30% larvae; near Two Island Lake: Cook Co.
55% pupae; 45% larvae; near Devil Track Lake: Cook Co.
Mostly emerged adults; a few still in pupal cases; Ely, St Louis Co.

18 55% larvae; 45% pupae; Jackson Lake Road: Cook Co.

27 Moths emerged and flying; Echo Trail: St Louis Co

YELLOWHEADED SPRUCE SAWFLY

Pikonema alaskensis (Rohwer)

ACREAGE: The acreage was not determined. The major impact of this insect is to shelterbelts, ornamentals, and roadside trees.

SEVERITY: Light to moderate defoliation was common. This rating is defined as less than 20% of the current year needles consumed for light defoliation to less than 50% of the current year needles consumed for moderate defoliation.

TREND: This defoliator is present every year. During the 1970's, damage to young state and industrial plantations was heavy in north central Minnesota. During the 1980's, damage and activity was lighter, but Christmas tree growers did spray to preserve foliage. In the late 1980's into the 1990's, reports of spruce defoliation from landowners and homeowners seem to be increasing.

REGIONAL NOTES

REGION 1

Significant activity of the yellowheaded spruce sawfly occurred throughout this region. Inquiries such as "what are the worms on my spruce trees?" and "why aren't there any needles on the ends of the spruce branches?" were more common during 1991 than during any year in the past. Some trees were more than 50% defoliated indicating that this insect had been feeding on the trees for a number of years.

REGION 3

As in past years, there were sporadic observations of yellowheaded spruce sawfly damage to white spruce saplings. Light defoliation was observed on roadside trees in S2-T44N-28W in Crow Wing County. The trees were 10-14 feet tall.

PHENOLOGICAL NOTES

JUNE

18 Larvae 5/16" to 5/8" long: Crow Wing Co.

27 Larvae on ground/cocooning: Aitkin Co.

WHITE SPRUCE CONE INSECTS

Choristoneura fumiferana (Clemens)
Cydia strobilella (L.)
Coneworms
Dasineura rachiphaga (Tripp)
Hylemya anthracina (Czermy)

REGIONAL NOTES

REGION 2

ACREAGE: 10 acre seed orchard

SEVERITY: In 1991 39.7% of the cones were attacked by one or more insect.

TREND: 1990: 87.3% of the cones attacked
1989: 23% of the cones attacked
1988: 12% of the cones attacked

Four hundred cones were harvested on July 30, 1991 and dissected to assess insect incidence. Twenty cones from each of 20 trees representing 19 different clones were dissected and examined. Results follow:

PEST	INCIDENCE[1]
All insects	39.7%
Choristoneura fumiferana	4.2%
Coneworms	4.7%
Cydia strobilella	3.5%
Dasineura rachiphaga	9.7%
Hylemya anthracina	25.2%

Overall 60.2% of the cones were not damaged by insects.

[1] Percentages are not additive since some cones were attacked by more than one species of insect.

For more detailed information, see "White Spruce Seed Orchard Cone Pest Studies" in the SPECIAL PROJECTS section.

CEDAR LEAF MINERS

(Species Not Identified)

REGIONAL NOTES

REGION 2

ACREAGE: Not determined

SEVERITY: Up to 50% of shoots died

Damage caused by leaf miners was common in northwestern Itasca and through much of Koochiching County. The leaf miners caused browning or scorch of the foliage. The insect causing the damage was not identified. There are 3 or 4 species that may be involved. No significant tree damage is expected, but tree mortality has been reported in southeastern Ontario.

GYPSY MOTH

Lymantria dispar (Linneaus)

ACREAGE: No defoliation occurred during 1991. However, 1 moth was trapped by DNR personnel in a private campground in Carlton County.

SEVERITY: No defoliation

TREND: Trap catches were down to 51 moths (statewide) from a high in 1990 of 126 moths. No moths were caught in traps in Rochester or in a Pequot Lakes campground where moths were caught during 1990. There were no spray projects for gypsy moth control in Minnesota in 1990.

SURVEY: DNR personnel placed, monitored, and retrieved 595 traps. In addition, the US Forest Service placed 290 traps on federal lands in Minnesota. Most of the traps were located in the Chippewa and Superior National Forests.

PROJECT: A gypsy moth card and poster were developed to help the general public better recognize gypsy moth and to increase the awareness of owner's of recreational vehicles to the potential for spreading gypsy moth. A more detailed description of this project and an example of the card and poster can be found in the SPECIAL PROJECTS section. The report is titled "Gypsy Moth."

STATEWIDE GYPSY MOTH TRAP CATCH SUMMARY

COUNTY	MOTHS	MULTIPLE CATCHES
ANOKA	1	0
CARLTON	1	0
CASS	1	0
CHISAGO	2	0
DAKOTA	18	4
HENNIPEN	24	3
RAMSEY	2	0
WASHINGTON	2	0

REGIONAL NOTES

REGION 1

154 traps placed; 0 moths caught.

REGION 2

One hundred forty one gypsy moth pheromone traps were set out by Division of Forestry and Division of Parks personnel. A single male moth was caught in a trap placed in a private campground in SESW of S36-T49N-R17W near Carlton in Carlton County. A more intensive survey will be conducted around this location in 1992.

REGION 3

180 pheromone traps were placed in State Forest Campgrounds, State Parks, Camp Ripley and on private lands. No moths were caught in DNR-placed traps. However, the US Forest Service caught a single moth in Cass County. That moth was taken on the Chippewa National Forest in S10-T141N-R27W at the Maple Lake Campground.

In 1990, a single moth was caught in the Pequot Lake District at a private campground, NESW of S2-T136N-R25W. In conjunction with the Department of Agriculture, a delimiting trapping scheme was set up. DNR personnel set out and monitored 25 traps; 18 traps in T136N-R25W and 7 traps in surrounding townships. No moths were caught.

REGION 5

In 1990, 120 detection traps were again placed across the southeast in state parks and forest stations. No moths were reported from these traps.

REGION 6

Pheromone traps caught a much smaller number of moths during 1991 than in 1990. The moth catch in this Region was 47 in 1991 as opposed to 125 in 1990. The record catch was 580 in 1984. This decrease was due to eradication programs conducted by the Minnesota and US Departments of Agriculture. All pheromone trapping in Region 6 was coordinated by the Minnesota Department of Agriculture.

The best news was that no moths were taken at either of the two sites treated in 1990. Unfortunately, catch patterns indicated two probable isolated infestations in the Region. One site was in Minneapolis in the Lake of the Isles area. The other site was in Apple Valley. An egg hunt at the Minneapolis site found no egg masses. The egg hunt at the Apple Valley site was postponed until spring due to the Halloween Blizzard of October 31 - November 1, 1991.

FOREST TENT CATERPILLAR

Malacosoma disstria Hubner

ACREAGE: 1,645,000 acres (See Map 2.)

SEVERITY: Light to moderate defoliation (<50%): 1,230,300
Heavy defoliation (>50%): 415,000

TREND: This current statewide infestation began during 1987. The years with the greatest area of defoliation were 1989 and 1990. Both years had over 4,000,000 acres defoliated; however, during 1990 defoliation was much more scattered and in many locations populations actually declined from 1989 levels. In 1991, populations, acres, and levels of defoliation declined dramatically and are expected to continue to decline in 1992. The exception to this general statewide decline is west central and southern Minnesota. Populations around lakes in these parts of Minnesota have existed at varying intensities during the decade of the 1980's, and it is unknown how long populations will remain active.

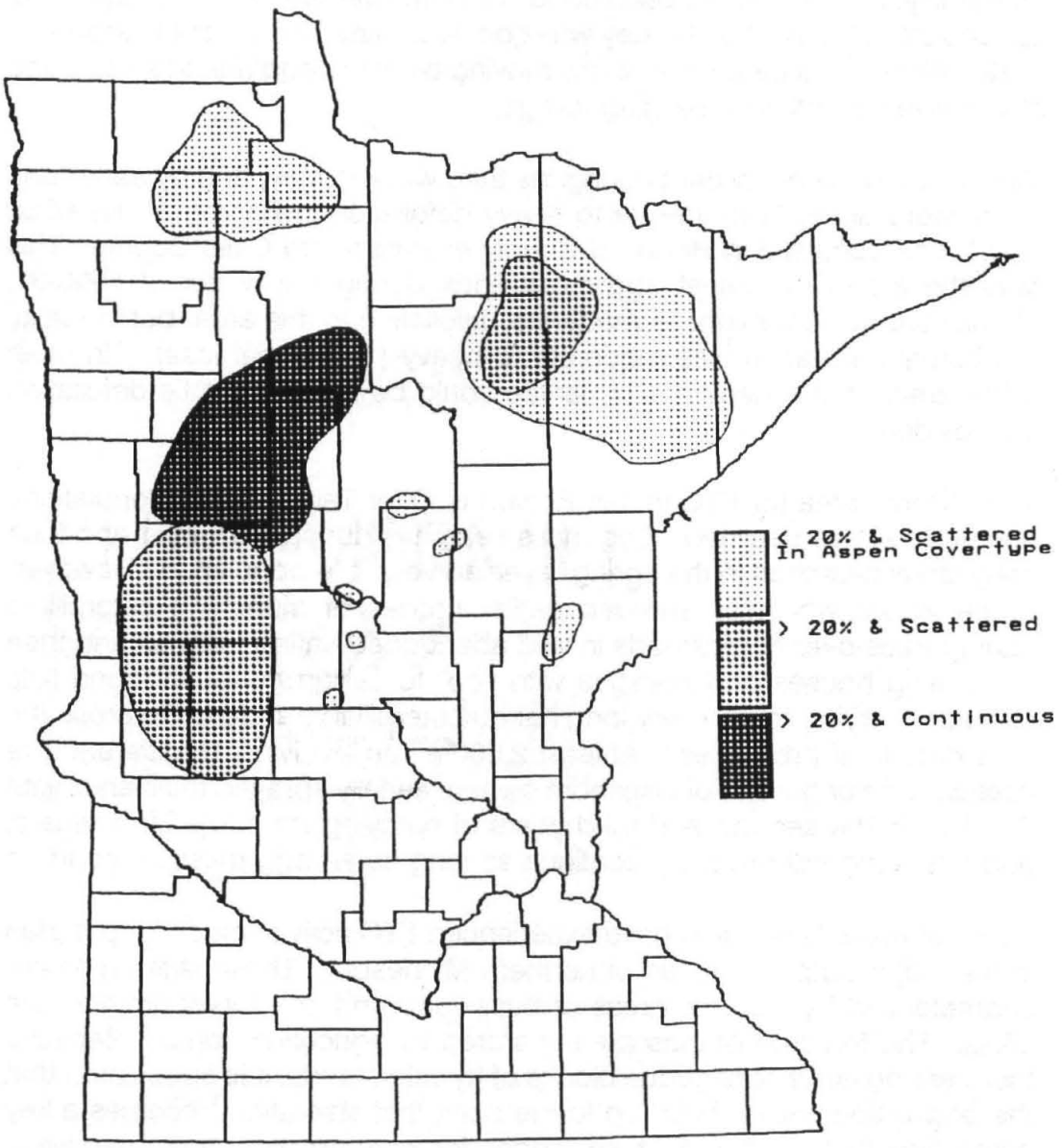
SURVEY: Aerial and ground detection surveys as well as egg mass surveys were conducted on 6,000,000 acres during 1991. Egg mass survey results can be found in the SURVEY RESULTS section.

REGIONAL NOTES

REGION 1

Defoliation in this Region during 1991 amounted to 25,000 acres. This acreage figure represents a steady decline in FTC activity. In 1989 defoliation occurred to 531,500 acres. In 1990 this figure had dropped to 73,500 acres.

Map 2. Forest Tent Caterpillar Defoliation, 1991.



Forest tent caterpillar starting to hatch in this Region on April 26. Reports of hatching on that day were received from Ottertail County, and egg masses were observed hatching in Bemidji. Ottertail County is 70-100 miles south of Bemidji, and vegetation development between the two sites is different. Despite this north-south separation and vegetation development differences, egg mass hatching seemed to have occurred simultaneously over a large area.

In Bemidji, hatching was observed to continue over the next two days, April 27 and 28. On April 29, the day was cool and rainy, and hatching stopped. Caterpillars could be seen that day moving off of the egg masses and lining themselves on newly emerging foliage.

Defoliation became evident during the third week in May, and by early June there were areas of moderate to heavy defoliation in Region 1. Heaviest defoliation occurred in Hubbard County eastward into Cass County. This was the area of heaviest egg mass finds during the winter of 1990-91. Predictions were for light to moderate defoliation in this area, but in reality the actual defoliation was moderate to heavy (>50% leaf loss). In most other areas in the Region, FTC larvae could be found but little defoliation was evident.

The chronic area for FTC in this Region is Otter Tail County. Populations seemed to have declined. Egg mass searches during the winter and then early larval searches in the spring revealed very little population. However, homeowners who had survived earlier hordes of munching caterpillars raining frass over homesteads in wild abandoned eating frenzies and then decorating houses and garages with floor to ceiling cocoons found little remorse in trying to kill every long haired caterpillar that dared to cross the lines onto their properties. At least 2,500 acres involving 15 different lake associations or groups of lakeshore owners aerially sprayed their lands with Bt. This is the second and third years of spraying for some landowners, and this trend will probably continue as long as an egg mass is found.

Some of these lake areas have experienced FTC activity much longer than in the major outbreak areas of northern Minnesota. These lake areas are characterized by discrete areas of basswood and oak forest rimming the lakes. The forested islands are separated by agriculture lands. Because there are no large contiguous blocks of forested lands, it is speculated that the populations never build up to the point that starvation becomes a key controlling factor. It may take longer for naturally occurring parasites,

predators, and diseases to build up in these populations to cause a significant population collapse.

REGION 2

Forest tent caterpillar was the primary defoliator of aspen; however, aspen leaf rollers were again common. Aspen web worm and a number of other insects also caused widespread late season defoliation.

Forest tent caterpillar populations began to decline in 1990 when much of the hatch occurred early and was followed by snowy, freezing conditions. Snow and freezing weather occurred again this spring after some of the egg masses had already hatched. These conditions appear to have contributed to the population decline.

Populations of the gray or friendly fly, *Sarcophaga aldrichi* Park were again very high in most of the defoliated areas. Many of the private callers stated they would prefer the caterpillars to the flies. Rumors again persisted that the DNR was importing and releasing the flies.

In locations where cocoons were examined it appeared that moths had emerged from less than 5% of the cocoons. Most cocoons appeared to contain dead, diseased, or parasitized forest tent caterpillars.

An eggmass survey was conducted during the winter of 1990-1991 to predict 1991 defoliation levels. Results are listed in the SURVEY RESULTS section.

REGION 3

Defoliation occurred on 30,000 acres in this Region, but it was very light to light, or less than 20% of the leaves were consumed. Defoliation was very minor compared to previous years. Counties with detectable defoliation were Stearns, Morrison, Todd, Cass, Crow Wing, Aitkin and Pine. The declining defoliation intensity and acreage signal the final stages of population collapse in this region. See FTC defoliation predictions from egg mass survey in SURVEY RESULTS section.

REGION 5

Defoliation occurred on 1,500-2,000 acres in this Region. Defoliation was generally light to moderate, less than 50% of the leaves consumed. Many areas were a mosaic of lightly defoliated and unaffected hardwoods.

In northern Kandiyohi county the defoliation was very widely scattered over many small separate areas. In Meeker county there were a few large areas of defoliation in the northeastern part of the county.

Defoliation in 1991 decreased slightly over 1990 levels. Most of the defoliated areas were south of Norway and Green Lakes but north of Willmar. These forests are characterized by rich variety of hardwood species including basswood, northern red and bur oaks, some aspen, birch, elm, and other species. This diversity of food sources, site conditions, and the geographical isolation of these insect populations may contribute to the persistence of the forest tent caterpillar in these forests.

Forest tent caterpillar defoliation has been occurring in these areas at varying levels for over ten years. Aerial applications of Bt to private lands continued in 1991. Bt applications began in 1989 in a successful attempt to remove the nuisance caused by armies of caterpillars in early June when people were trying to camp or enjoy lake homes. Coordinated efforts to use Bt began with public meetings and continued with personal contacts with county officials and lake homeowner associations.

Each year DNR specialists field evaluated larval and foliage development in order to properly time the single Bt application. The timing for a single application is in the third week in May and coincides with a 40% leaf development on bur oak. At this time there is an abundance of target foliage for the Bt on a variety of species; yet, good canopy penetration is achieved. Larval development can range from 2nd to 4th instars at this time. Dipel 8L at the rate of 8 BIU per acre with the addition of 2% Plyac sticker has been used. Total spray volume is one gallon per acre.

Oak mortality has occurred due to the combined effects of several years of defoliation, the 1988 drought, and attacks by the two-lined chestnut borer. Mortality in red oak peaked in 1989 but has continued through this growing season. In 1991 bur oak mortality was greater than red oak mortality.

REGION 6

No forest tent caterpillar defoliation or activity was reported during 1991.

PHENOLOGICAL NOTES

APRIL

26 Eggs hatching: Ottertail, Beltrami, and Koochiching Cos.
28 10% egg masses hatched: Itasca Co.
29 Snow; temp = 22 °F at 10PM: Grand Rapids, Itasca Co.
Larvae moving off of egg masses: Beltrami Co.

MAY

17 Larvae 3rd instar, 5/8 inch long: Brookston, St Louis Co.
21 3rd-4th instar, approximately 1" long: Grand Rapids, Itasca Co.
23 3rd-4th instar; black masses of caterpillars evident: St. Louis Co.

JUNE

6 Pupation beginning: Cass Co.
4th to early 5th instars: Brookston, St Louis Co.
9 5th instar; 1&3/8"long; *Sarcophaga* flies present: Aitkin Co.
11 40% pulling leaves together to pupate; 10% pupated: St. Louis Co.
40% pupated: Cotton, St Louis Co.
12 75% pupated; 25% larvae: Cook, St Louis Co.
19 *Sarcophaga* flies still present: Morrison Co.
24 Larvae present appear sick; most moths emerged: Itasca Co.
27 Moths emerged; diseased larvae present: Echo Trail, St Louis Co.

ASPEN WEBWORM

Tetralopha aplastella (Hulst)

ASPEN LEAFROLLERS

Pseudexentera oregonana Walsingham
Anacampsis innocuella Zeller
Sciaphila duplex Walsingham

ACREAGE: Not determined

SEVERITY: Light to moderate defoliation (<20 to <50% defoliation)

REGIONAL NOTES

REGION 2

In eastern Itasca and through most of St Louis Co., aspens experienced late season defoliation during late July and through August. When first observed, the aspens looked like they didn't refoliate very well after the FTC defoliation. Upon closer inspection, a number of different larvae were found causing new defoliation. Several species of leaf rollers were present, but the most damaging insect was tentatively identified as the aspen webworm. Webworm larvae are small, approximately 1 cm long, and live in a cluster of several dry, crumpled leaves. Some of them construct a tube made of silk and frass inside their leafy shelters.

REGION 3

This Region has had little defoliation caused by leafrollers until this year. There were four areas with moderate to heavy leafroller defoliation of their upper crowns. One area was in Crow Wing County in Mission Township, and the other three areas were in Cass County. One area was south of Remer, another near Emily, and the third area was along the west shore of Gull Lake.

Aspen webworm defoliation became apparent in early August. There were two locations of aspen webworm. Both areas were along State Highway 65 in the Jacobson District in Aitkin County.

PHENOLOGICAL NOTES

JUNE

7 Some species have started to pupate: Wadena Co.

JULY

22 Aspen being defoliated by aspen webworm: Goodland, St Louis Co.

AUGUST

9 Aspen crowns appear thin on top: Wadena Co.

TWO-LINED CHESTNUT BORER

Agrilus bilineatus (Weber)

ACREAGE: Not determined

SEVERITY: Scattered pockets of trees that had been partially top killed during earlier years died during 1991. It is estimated that mortality did not exceed 10% in those scattered pockets.

TREND: Top kill of red oaks began to become evident at the end of the 1988 growing season in central and southern Minnesota. In northern Minnesota, top kill and tree mortality first became evident during 1989. Mortality peaked in 1989 in southern Minnesota and in 1990 in northern Minnesota. During the peak years very high levels of mortality occurred in some areas. Some stands had oak mortality in excess of 50+% of all of the oaks in the stands. During 1991, mortality declined dramatically, and mortality was primarily limited to trees that experienced top kill during previous years and to bur oak. Bur oak mortality seemed to peak during 1991. As trees continue to recover from the drought, mortality is expected to decline further for all species of oaks.

SURVEY: Two surveys were initiated in 1990 to determine oak losses due to drought and the two-lined chestnut borer. The analyses and reports were completed during 1991. A synopsis of the report, entitled "Oak Mortality Survey" is found in the SPECIAL REPORTS section.

PUBLICATION: Management guidelines were written to help mitigate losses to the oak resource during the drought recovery years. These guidelines entitled, "Oak Mortality Guidelines for Management: Transition Years" can be found in the PUBLICATION section.

REGIONAL NOTES

REGION 1

Bur oak dieback and mortality was noted in 1990 in Kittson County. In July of 1990, samples of bur oak collected from declining oaks in this county had the telltale two-line chestnut borer galleries indicating borer activity during 1989. However, dieback was not evident until 1991. Reports also were received of bur oak dieback and mortality occurring in North Dakota and Manitoba during 1990.

Drought conditions intensified during the summer of 1990 in northwestern Minnesota. During 1991, bur oak dieback in some parts of the Northwest reached catastrophic proportions. Bur oak dieback and mortality was as common and as severe as in some of the harder hit counties with red oaks in central Minnesota. One particular woodlot approximately 20 acres in size experienced 90%+ bur oak mortality. This was particularly significant since bur oak was the only species of tree in the woodlot. This was higher mortality than was ever observed in any woodlot in central Minnesota.

The occurrence of bur oak dieback and mortality leads one to make the following observations:

* There are no tree species immune to the effects of a severe drought. Even species that have adapted to growing in locations which are always in a drought situation for most species of trees, does not guarantee that these adapted species will escape the drought.

* With species that are more drought tolerant, drought effects tend to show up 2-3 years after it shows on species that are more drought sensitive.

* Where drought tolerant species occur there usually are not a lot of other species of trees to choose from. The drought tolerant species are the ultimate fall back species, and when those are lost the tree cover is lost.

REGION 2

Mortality in oaks was initiated by the drought. Stressed oaks were attacked by secondary agents such as two-lined chestnut borer and *Armillaria* root rot. Of the two, the borer has been the most obvious. However, during 1991 *Armillaria* root rot began to become more evident. Mycelial fans and rhizomorphs could be found developing under the bark on the trunk of dead oaks.

In 1991 the only oaks that died were ones that had suffered some branch mortality or top kill in 1989 and 1990. No oaks were noted dying in 1991 that did not have apparent branch mortality from previous years.

Damage, in 1991, was most obvious in Itasca, Carlton, Cass and southern Lake Counties.

REGION 3

In most areas, new infestations that were initiated during 1991 were very rare. Peak mortality occurred in 1989 in the southeastern counties of the Region and in 1990 in the central and northwestern counties of the Region. When wilting or mortality was observed during 1991, it was in the oaks that were attacked and weakened in 1989 or 1990.

In northwestern Cass County, aerial and ground surveys were conducted to determine the location and severity of past and current TLCB-caused mortality. See map. As of August 27th, rainfall in the Backus Area was 2 and 1/2 inches below normal for the month and 4 and 1/2 inches below normal for the year.

The foresters in this Region were concerned about trying to predict the health of the oak resources. Knowing the condition of the oak would help the foresters target appropriate management actions. Management actions would differ in stands that had recovered from the drought compared to the stands that were still too stressed to be disturbed by any kind of management activities.

Dr. P. Wargo, USFS, developed a technique to estimate the vigor of trees based on the starch content of their roots. Starch content of the roots is

a reliable and sensitive indicator of a tree's vigor or, conversely, stress. By combining the vigor ratings of trees from sampling areas that adequately represent the stand in question, the vigor of the stand can be determined. This technology is best used as part of an overall evaluation of the stand. Root starch content measurements combined with previous borer attack information, the presence of recently dead trees, a rating of crown symptoms, and the presence of *Armillaria* root rot can be used to make a judgement as to stand vigor.

On September 4, three oak stands were visited and trees were selected for sampling. Small plugs of wood were extracted from the root flare below the groundline. The plugs were cut into very fine sections to display the ray tissues. Sections were stained using a potassium iodide solution, and the sections were visually rated for the presence of dark-staining starch in the tissues.

Brainerd Area personnel were satisfied that they could use this technique in the field to determine if thinning/harvesting activities could be initiated for the stands examined.

Region 5

Very light individual oak tree mortality continued across the southeast during 1991. The peak in oak mortality due to the 1988 drought occurred in 1989. Losses in the southeast hardwood forests were light and estimated at less than 1%.

In 1991, oak mortality in the southeast occurred mainly to bur oak but did include some red oak mortality. The individuals that died were primarily in urban areas or on very poor or over stocked forest sites. In some of the urban areas the bur oaks killed by the two-lined chestnut borer were in stands that were leaf scorched in 1988 during the height of the drought. In addition the trees that died had their root systems disturbed close to the time of the drought by either construction or landscaping.

In 1991, field checks of wilted bur oak found high concentrations of two-lined chestnut borer galleries not only under the bark at breast height but often all the way down to the root flares. *Armillaria* root rot was also evident on a few of these trees at the root flares. It may take two or more years for

the two-lined chestnut borer to kill bur oak. In contrast, field checks of recently wilted red oaks did not often find the two-lined chestnut borer galleries all the way down the stem.

This drought has shown that there is a differential reaction in mortality between the bur and red oak species. Bur oak mortality became evident 2-3 years after red oak mortality became evident.

REGION 6

Two-lined chestnut borer continued to kill significant numbers of oaks over most of the northern parts of the region. The most serious activity was found on sandy soils in Anoka County where landowners often confused this insect with oak wilt. One landowner had undertaken a massive trenching project, treating every tree at the first sign of a branch dying. No oak wilt was found on his property.

Two-lined chestnut borer damage has two characteristics that normally distinguish it from oak wilt. First, the damage occurs as scattered individuals in a stand. Oak wilt normally occurs as a well defined infection center. Second, borer killed trees normally begin to wilt about two to three weeks after oak wilt infected trees. Additionally, borer infected trees wilt slower, usually attack white and red oaks equally in the same stand, and have large numbers of insect galleries under the bark.

PHENOLOGICAL NOTES

JULY

19 Leaf wilting becoming visible: Crow Wing and Morrison Cos.
25 Wilting becomes apparent: near Woman Lake, Cass Co.
29 Larvae 1 & 1/8" long: Birch Lake State Forest, Stearns Co.

BRONZE POPLAR BORER

Agrilus liragus Barter & Brown

ACREAGE: 500 acres

SEVERITY: 10-30% of the aspen in scattered stands were dead, and another 10-30% showing current year top dieback.

TREND: Scattered occurrences of this insect have been noted in the past, but this is the first time top kill and mortality have been associated with these occurrences.

REGIONAL NOTES

REGION 1

Merchantable sized aspen were first reported dying in T149N-R32W in Beltrami County during August of 1991. Upon further investigation, it was learned that some of the aspen had shown brown tops at the end of the 1990 growing season. When the stands were inspected, there was found a range of mortality and top kill. It was obvious that aspen had died during 1990, but more aspen were showing top kill and complete tree mortality occurred during the 1991 growing season.

All trees that showed crown symptoms had brown, pitchy spots on the bark. When these spots were cut into, the typical *Agrilus*-type gallery was found. When the bark was stripped beyond the pitch spots, the galleries continued. Some trees had galleries to the ground line. The appearance of the trees and the timing of crown symptoms closely matched that of the two-lined chestnut borer on red oaks.

Widely scattered occurrences of this insect have been observed in the past, but this is the first observation of mortality and top kill associated with this insect in Minnesota. The stands where mortality was observed occurred in a severe drought area during the 1990 growing season, and the soils tended to be gravelly and droughty. It is thought that this mortality is

closely related to drought stress, and with the return of normal precipitation patterns and amounts, little top kill and mortality should be evident in the future.

REGION 6

Bronze poplar borer was reported commonly over much of Washington County and was usually found in association with *Armillaria* root rot.

PEST CONDITIONS REPORT
DISEASES

- ✔ DIPLODIA BLIGHT AND CANKER
- ✔ FIR-FIREWEED RUST
- ✔ WHITE SPRUCE CONE RUSTS
- ✔ ASH YELLOWS
- ✔ ANTHRACNOSE LEAF DISEASES
- ✔ BUTTERNUT CANKER
- ✔ OAK WILT
- ✔ DUTCH ELM DISEASE
- ✔ ARMILLARIA ROOT DISEASE
- ✔ DAMPING OFF IN NURSERY BEDS

DIPLODIA BLIGHT AND CANKER

Sphaeropsis sapinea (Fr.:Fr.) Dyko & Sutton

ACREAGE: Not determined

SEVERITY: Top kill and tree mortality

TREND: This disease is endemic in Minnesota. When moisture conditions are good, infections take place and kill shoots. When trees are stressed, infections spread and the fungus forms cankers. Often the cankers will kill portions of the tree, or the entire tree will be killed. The drought has provided the stress, and the incidence of top kill and complete tree mortality has increased during the past 3 years. Since drought conditions have abated in Minnesota, the incidence of cankers from this disease should also decrease.

REGIONAL NOTES

REGION 1

This disease was once again found in the Park Rapids area killing branches and tops of red and jack pines. When one wants to find examples of this disease, the Park Rapids area always provides. During wet years, the shoot blight phase of this disease can commonly be found in the Park Rapids area. During drought years, cankered branches and trees, and tree mortality can also be found in this area.

In a mixed plantation of black spruce and white spruce in S2-T156N-R35W, Beltrami County in the Grygla Field Station area, dead and dying black spruce were observed. When samples were sent to the Forest Pathology Diagnostic Lab in Grand Rapids, dissections revealed that long horned wood boring beetles were present in the nodes of trees with fresh topkill. Upon further investigation of other samples, *Sphaeropsis* fruiting bodies were found on cankered areas on the main stems. It was hypothesized that the beetles were secondary insects attacking the drought-stressed and *Sphaeropsis*-infected black spruce.

This is the first report of *Sphaeropsis sapinea* on black spruce in the United States. Earlier this year, this disease was first reported on black spruce near Sioux Lookout in Ontario.

In 1962 and 1963, this plantation was established with both white and black spruce. The soils are well drained sandy to loamy sands making the site not ideal for black spruce. The black spruce are 25-30 feet tall, average 5" DBH, and there is no overstory in the plantation.

Disease symptoms included dead and top-killed black spruce with perennial cankers on the main stems and branches. The cankers on the main stems were sunken and resinous, and in some cases 4-5 feet in length. Some pycnidia were found under the outer bark flaps, but the occurrence was not common compared to the extent of cankering. No pattern of disease occurrence was noted in any of the plantations; however, only the black spruce had top kill and tree mortality. There was an occasional white spruce that had a flagged branch with a canker associated with the flag.

REGION 2

Two areas of significant *Sphaeropsis* occurrence were found in Koochiching County. In S23-T155N-R25W dead trees, tops, and branches of 10 to 30 foot tall red pines were associated with the presence of *Sphaeropsis sapinea*. Two to 10 foot tall red pine, in a 20 acre plantation in S25-T155N-R25W suffered a high level of mortality due to the combination of J-rooting, drought, and this disease.

In St. Louis County on an island in Vermillion Lake, top kill and branch mortality were observed in mature red pine. These pines had also sustained storm and bark beetle injury. *Sphaeropsis* also caused damage to large red pines in a picnic area on Island Lake north of Duluth. These trees also suffered from winter injury and drought.

In Itasca County in Grand Rapids, an ornamental planting of Mugho pines suffered tree mortality and shoot dieback due to infections by *Sphaeropsis sapinea.*

FIR-FIREWEED RUST

Pucciniastrum epilobii Otth

ACREAGE: Not determined

SEVERITY: Incidences varied from 0 to 65% of current year needles infected with this rust.

REGIONAL NOTES

REGION 2

This rust was common but not abundant throughout Region 2. It was abundant in a Christmas tree plantation in northern St Louis County. Yellow spores (aeciospores) were produced in mid-June on current year needles of balsam fir. These spores infect the alternate host, fireweed. The infected needles turn brown and eventually drop off the trees. To minimize the impact, shearing of shoots with heavy needle infection was recommended. This reduces the length of bare shoots and the tree will fill in quicker. Control of fireweed in and around the plantation was suggested as a way to reduce future needle rust infections.

PHENOLOGICAL NOTES

JUNE

12 Aeciospores on current year needles; balsam fir: Orr, St Louis Co.

WHITE SPRUCE CONE RUSTS

Pucciniastrum americanum (Farl.)
Chrysomyxa pirolata (Wint)

REGIONAL NOTES

REGION 2

ACREAGE: 10 acre seed orchard

SEVERITY: 13.6% of cones infected by rust fungi overall.
13.5% of cones infected by *P. americanum.*
0.1% of cones infected by *C. pirolata.*

TREND: Incidences of rust infection in 1989 was 16.8% and in 1990 was 14.4%.

One thousand unsprayed cones were inspected for rust incidence in the seed orchard on June 23, 1991. Fifty cones from 20 trees representing 19 different clones were inspected. Cones were rated as infected or not infected. Results are listed above in the "SEVERITY" summary. The number of rust pustules per cone was also determined.

For more details, see "White Spruce Seed Orchard Cone Pest Studies" in the SPECIAL PROJECTS section.

ASH YELLOWS

Mycoplasma-Like Organism

REGIONAL NOTES

REGION 5

In 1991 no new cases of ash yellows were reported. There was widespread dieback of green ash growing in urban areas across southeastern Minnesota. This dieback is not because of ash yellows disease but is attributed to the long term effects of drought and winter injury. See "Ash Dieback" in the ABIOTICS section.

One suspect tree was sampled from Plainview. A root sample was sent to Wayne Sinclair, at Cornell University. The DAPI fluorescence stain test used for diagnosis was negative.

The University of Minnesota is now set up to do the staining for and diagnosis of the MLO. This should speed up diagnosis and allow a quicker response to the occurrence of this disease.

REGION 6

One tree from Roseville that was confirmed positive for ash yellows during 1990 was removed in early May. As a precaution, the entire crown, stem and branches were chipped. The root system was also ground out, and no root suckering occurred. No new trees were discovered by DNR-Forestry during the summer, but during the fall several trees on the University of Minnesota campus in St. Paul were diagnosed positive for ash yellows.

ANTHRACNOSE LEAF DISEASES

Apiognomonia quercina
Apiognomonia errabunda
Glomerella cingulata

ACREAGE: Not determined

SEVERITY: Moderately high levels of infection and defoliation occurred in southern Minnesota. Minor infections with very little defoliation occurred elsewhere in Minnesota.

TREND: These diseases are closely related to wet conditions. Since 1987 when the drought began, these foliage diseases have had very little impact. The drought has been very minimal in southern Minnesota during 1990 and 1991, and heavy rains did periodically occur from the Twin Cities and southward. Predictably, anthracnose diseases have increased. As more normal precipitation amounts and patterns occur elsewhere in the state, these diseases should increase.

REGIONAL NOTES

REGION 1

Response to homeowner calls from Beltrami and Hubbard Counties revealed that both green ash and black ash trees growing in yards showed browning and curling of some of the lower leaves. Very little defoliation occurred. If these infected leaves were not destroyed and conditions are wet early in the growing season in 1992, anthracnose will increase.

Region 5

Outbreaks of anthracnose occurred at varying times and on many species all across the Region. In early summer ash trees were heavily defoliated followed by black oak, then walnut, maple, and finally bur oak. The outbreak in black oak in mid-June was widely spread over several southeastern counties. Northern red oak growing among the bur oak remained unaffected.

BUTTERNUT CANKER DISEASE

Sirococcus clavigignenti juglandacearum Kuntz

REGIONAL NOTES

REGION 5

ACREAGE: Not determined

SEVERITY: This disease has caused extensive butternut mortality and now butternut is relatively rare in its natural range.

TREND: A project was started in 1989 by the U.S. Forest Service and state cooperators to find trees resistant to this disease.

In 1991 scion wood was again collected from several canker-free trees growing in southeastern Minnesota. Another excellent stand of butternut was found in Wisconsin in 1991. Additional genetic material is needed from eastern states.

North Central Forest Experiment Station is accumulating the large number of these grafts from all cooperators. General Andrews State Nursery has done a large number of grafts using the collected scions. There are plans to begin some initial screening of these grafts by greenhouse inoculations. Developing procedures for producing butternut from tissue culture has been slow. Proper techniques for nut-bearing trees has yet to be worked out, and the butternut tissue culture is a pioneering effort.

OAK WILT DISEASE

Ceratocystis fagacerum (Bretz). Hunt

ACREAGE: This disease is estimated to infect 1000-1500 acres in southeastern Minnesota counties. A 1988 survey in Metro Region counties found approximately 5,000 acres infected.

TREND: Oak wilt has likely been present in Minnesota since the turn of the century. Although the oak wilt fungus was first described and identified in Wisconsin in 1942, an earlier report indicated that it was present in the region as early as the 1880's. The disease is now found in at least 21 states and more than 600 counties. By 1988, oak wilt in Minnesota had been reported from 31 counties, mainly in the southeastern and east central portions of the state. Construction damage to oaks during May and June allows oak wilt to spread into new areas. Oak wilt incidence and acreage in the Metro Region are expected to increase as urban sprawl increases.

REGIONAL NOTES

REGION 3

The control sites on the Sand Dunes State Forest in Sherburne County suffered no breakover infections in 1991. One tree died adjacent to plowed line at one of the four sites, but this tree was infested with two-lined chestnut borer. It is not uncommon to find this borer in trees adjacent to plow lines since plowing severs a significant proportion of the roots.

Sherburne County has developed an aggressive oak wilt program. Funded by the county, the County Tree Board worked with individuals and treated 27 infection centers in 1991.

REGION 5

In 1991 no new vibratory plow control demonstrations were conducted in southern Minnesota. However, numerous control recommendations are made each year.

REGION 6

Oak wilt became more evident in the northern part of the Metro Region this year. It was been present all along, but its presence was masked by the massive mortality triggered by the 1987-89 drought. Oak wilt infected trees began to actively wilt in large numbers about July 3. In contrast, two- lined chestnut borer attacked trees began to fade about two weeks later, around July 18th. *Armillaria* root disease became evident about August 14th.

A vibratory plow, specially modified for oak wilt control, was cooperatively purchased in 1991. The plow was paid for by state and federal funds, and was delivered to Anoka County in late August. The plow was officially presented to Anoka County in a ceremony held in conjunction with the Oak Wilt Inspection Tour on September 5th. This tour was held by the Anoka County Tree Board and sponsored by DNR-Forestry. Two twin engine aircraft were chartered for a special air tour of northwestern Anoka County highlighting oak wilt. The press attended in mass with all 4 Twin Cities TV stations running major stories that evening. Approximately 75 people took the tour.

The vibratory plow was used in one community this fall before a premature blizzard, the Halloween Blizzard, terminated plowing for the year. Lino Lakes was the only community to use the plow in 1991 with 28 infection centers treated. Four communities were prepared to use the plow in November. Normally, the plowing season extends until late November or until about 4 inches of frost are present in the soil. In accordance with the purchase agreement between DNR and Anoka County, the plow is available to any Anoka County community that develops an Oak Wilt Control Plan. There is no charge to the community except for repairs caused by carelessness. As of January 1, 1992, approximately 10 Anoka County communities were preparing plans and were expected to be using the plow in 1992.

In addition to use of the county plow, an estimated 100 additional infection centers were treated by private contractors.

DUTCH ELM DISEASE

Ceratocystis ulmi (Buisman) C. Moreau

REGIONAL NOTES

REGION 5

There was a noted increase in this disease in rural areas across southeastern Minnesota in comparison to the recent past.

REGION 6

The trend is downward for this disease in this region. Few cities keep accurate records of losses, but Minneapolis' losses measured by city removals were only 2,912 in 1991. There was a decrease from 3,884 in 1990 and 5,384 in 1989. This trend may illustrate the decreasing population of elms in the Region.

ARMILLARIA ROOT DISEASE

Armillaria spp.

REGIONAL NOTES

REGION 6

Armillaria root disease became common in the Metropolitan region in 1991. Infections occurred on individual trees, but discrete infection pockets were found in aspen in Washington County and in oak in Anoka County.

DAMPING OFF IN NURSERY BEDS

Fusarium spp.

ACREAGE: State and private forest nurseries

LAB NOTES

Dead and dying germling red pine were found in early June. Lab culturing showed 30% recovery of *Fusarium* species from samples. No other pathogens were recovered.

PEST CONDITIONS REPORT
ABIOTICS

- ✔ BIRCH MORTALITY
- ✔ BALSAM FIR MORTALITY
- ✔ MAPLE LEAF SCORCH
- ✔ HAIL DAMAGE
- ✔ AIR POLLUTION INJURY

BIRCH MORTALITY

Drought, Defoliation, Age, and Bronze Birch Borer

REGIONAL NOTES

REGION 2

ACREAGE: Not determined; mortality occurred region wide

SEVERITY: 75+% mortality in some stands

TREND: High levels of mortality began to show up in 1991. Mortality is likely to continue in 1992, but the incidence is likely to decline.

Extremely high levels of mortality occurred in 1991 throughout the Region but were especially evident in Itasca, St Louis, and Carlton Counties. In some woodlots greater than 75% mortality was reported. The mortality was primarily initiated by the drought. Most severe mortality occurred in mature and overmature birch on sandy soils and ridgetops.

Birch in much of the Region has been defoliated over the past several years by the forest tent caterpillar. Levels of birch leaf miner have also been high through much of the Region, often causing trees to turn brown by mid to late summer. Loss of foliage especially when the loss is great enough to trigger a refoliation is very stressful to the trees. A second production of leaves during a single growing season or a browning of leaves which reduces the photosynthetic capability of the trees depletes food reserves in the roots. With diminished food reserves, the trees are not able to withstand other stresses such as drought and the bronze birch borer.

Bronze birch borer can be found in most dead and dying birch. It is often termed a "secondary" organism because it is more abundant when trees are under stress and there is evidence to suggest that a "healthy" tree can defend itself against a bronze birch borer attack. However, when populations build up due to the abundance of large numbers of stressed trees, it may very well be a "primary" agent of tree mortality.

BALSAM FIR MORTALITY

Drought

ACREAGE: Not determined

SEVERITY: Tree mortality, top kill, and branch mortality

TREND: Damage appears to have peaked in late 1990 and during the winter of 1990-91. Incidence should decrease as trees continue to recover from the drought.

REGIONAL NOTES

REGION 1

Drought related balsam fir mortality is very common. Balsam fir is shallow rooted and grows in competition with or as an understory species. A common associate is aspen which has a more extensive root system and is better able to compete for limited moisture. During the years immediately following the 1976-1977 drought, balsam fir mortality was second only to paper birch mortality.

Balsam fir mortality was seen in particularly in Clearwater County during 1990. During 1991, balsam fir mortality was observed primarily in Itasca and Koochiching Counties in the Region. Mortality ranged from complete tree reddening to only a portion of the tree turning red. This situation should diminish, and it probably reflects the severe drought conditions experienced in these areas the latter half of the 1990 growing season.

REGION 2

Balsam fir of all ages and sizes died during the summer of 1990 and over the winter of 1990-1991, and this mortality became most evident during the spring and summer of 1991.

Trees in forests, windbreaks and backyards died. The most significant mortality occurred in Koochiching, Itasca, and St. Louis Counties. In St. Louis Co., mortality was most conspicuous across the Iron Range and north of Duluth. In many cases the entire tree died but in others the top 1/4 to 1/2 of the crown died while the bottom of the tree remained green. In some cases only individual branches died.

The drought was assisted by the balsam fir bark beetle. On trees where individual branches flagged and died, bark beetles could often be found in the tree trunk at the base of the dead branch.

MAPLE LEAF SCORCH

REGIONAL NOTES

REGION 5

Acreage: Not determined

Severity: Tree mortality occurred.

Trend: Mortality was likely a one-time event. No additional mortality is expected in 1992.

In late June and early July following moderate temperatures and abundant rainfall, there was a period of intense heat. Scattered large sugar maple in urban areas were completely leaf scorched and died. Reports have come from Olmstead County, Rochester (several), Zumbrota, Winona, and Spring Valley. This type of leaf scorch is common on young sapling transplants when planted in boulevards. These trees scorch because of intense heat combined with the absence of established root systems. The trees usually recover. Tree mortality from acute leaf scorching is a very unusual case. If correct, this would not be expected to occur again any time soon.

The southeastern area of Minnesota is often vulnerable to dramatic extremes in climatic conditions. When these extremes occur, the effects can often be seen indirectly in other ways. It was interesting to note that at generally the same time the maples were leaf scorching, Christmas tree plantations within the same area were affected by acute air pollution injury. See the report on air pollution injury in later in this section.

HAIL DAMAGE

ACREAGE: Not Determined

SEVERITY: Aspen mortality continued to be evident in Region 1 from a 1990 hail storm, In Region 2, 50+% of shoots on balsam fir affected from a 1991 hail storm.

REGIONAL NOTES

REGION 1

A hail storm during the night of August 25, 1990 continued to show its effects during 1991. This storm most severely damaged a 3-square mile area of primarily aspen woodlands in T150N-R27W in Itasca County. The initial report of the damage was made in the 1990 Forest Insect and Disease Annual Report. The immediate response to the damage was the shearing of young aspen sucker stands to prevent additional loses. These sheared areas did respond with sucker production during 1991.

During June of 1991, it became obvious that the impact of the hail storm continued to be evident. Larger, merchantable sized aspen stands in the main hail areas were leafing out very sparsely. Most trees had leaves, but individual tree crown reductions ranged from 60 to 90%. It was feared that the stress on these trees from the significantly reduced canopies and the many wounds serving as infection courts for disease organisms put these trees and these stands at great risk. Loss of both tree quality and volume would result as the trees start to deteriorate. Even more significant was the potential loss of the aspen stands as they gradually break up and lose the capacity to restock the sites because of reduced sprout vigor and production.

In consultation with the Area Wildlife Manager, it was decided to set up salvage sales and harvest these stands before they were allowed to deteriorate any further. There was concern that the large amount of new cutting along with the present acreage of 1-5 years old cuttings would have

a detrimental effect on wildlife populations in this area. The Area Wildlife Manager agreed that in the long run it was more important to cut the stands to regenerate them then to lose the aspen cover types.

Sales were set up in July and sold in August. The sale specifications stipulated that cutting could not start until after leaf fall (dormant season) and had to be completed by the following breakup season (March). 103 acres were set up in 6 sales involving 4,255 cords of wood. Average price for the aspen was $12.78 per cord.

These sale areas as well as the sheared areas will be monitored over the next few years or until adequately stocked stands of aspen occur.

Both the sheared areas and the salvage areas are intermingled with lands belonging to the Chippewa National Forest. The USFS also responded to the damage by setting up special sales during the summer of 1991. They, however, had not sheared their young stands during 1990, waiting to see how the stands would look during the growing season of 1990. After consultation with pathologists from State and Private Forestry, they too decided to shear some of their young stands. It will be interesting to observe if there are any differences in the numbers of sprouts between federal lands sheared during 1991 and state lands sheared during 1990.

REGION 2

A hail storm that occurred either during the fall of 1990 or the spring of 1991 damaged balsam fir and aspen along a 20-25 mile stretch of State Highway 16 from Makinen to Cadotte Lakes in St. Louis County, T57N-R16W to T57N-R12W. The hail caused impact wounds which killed the tips of balsam fir branches. These branch tips, often 1 foot or more long, turned a bright orange-tan color. The hail also damaged aspen in the area resulting in very sparse foliage.

AIR POLLUTION INJURY

REGIONAL NOTES

REGION 5

ACREAGE: Not Determined

SEVERITY: Acute needle tip burn in white pine Christmas tree plantations

Following the intense heat in June, there were a number of Christmas tree plantations injured by air pollutants along the Mississippi River in Wabasha County. SO_2 (sulphur dioxide) was suspected to be the cause of the foliage damage because the power plant on the Wisconsin side of the river burns coal. However, it is not uncommon during periods of high pressure, stationary air masses, and high temperatures for O_3 (ozone) to reach levels that would produce the types of symptoms on white pine that were seen in these plantations.

In most years some needle tip burn occurs to white pine in this area of Minnesota. However, the level of injury that occurred during 1991 has not been observed in this area in the past. Eastern white pine displays a great amount of variation in susceptibility to air pollution injury. This was evident in these white pine plantations. Some white pine were adversely affected while other trees in the same plantation showed no effect.

INCIDENTAL PEST OCCURRENCES

- ✔ INSECTS
- ✔ DISEASES
- ✔ ANIMAL
- ✔ ABIOTICS

PEST	HOST	COUNTY	NOTES
INSECTS			
Ash plant bug *Trapidosteptes* spp.	Ash	St. Louis	
Aspen blotch miner *Phyllonorycter tremuloidiella*	Aspen	Becker Beltrami Clearwater Hubbard	Heavy occurrences
Aspen serpentine miner *Phyllocnistis populiella*	Aspen	Crow Wing	S21-T44N-R30W on August 7
Balsam fir bark beetle *Pityokteines sparsus*	Balsam fir	Beltrami Lake of the Woods	Causing branch and top kill
(No common name) *Contarinia citrina*	Basswood	Anoka	Fridley; August
Birch leaf miner *Fenusa pusilla*	Birch, paper	Region 2	Locally heavy on urban trees
Boxelder bugs *Leptocorus trivittatus*	Boxelder	Beltrami Cass Clearwater Crow Wing Hubbard	Heavy occurrences prompting many calls; bugs still active indoors in December; noted in June in Crow Wing
Willow sawfly *Nematus ventralis*	Cottonwood	Ramsey	August 31
Dogwood sawfly *Macremphytus testaceus*	Dogwood	Morrison	S1-T128N-R33W on August 7
Elm lacebug *Corythuca ulmi*	Elm	Aitkin	Severe feeding damage; leaves turned bronze color by July 29
Elm leaf miner *Fenusa ulmi*	Elm	Aitkin	In cocoons on July 29
Yellow necked caterpillar *Datana ministra*	Hardwoods	Scott	August 21
Fall webworm *Hyphantria cunea*	Hardwoods	Region 6	August 14
Crimson erineum mite *Eriophyses asceris*	Maple	Beltrami Crow Wing	Locally heavy on urban trees; June 5 in Crow Wing

PEST	HOST	COUNTY	NOTES
INSECTS			
American dagger moth *Acronicta americana*	Maple, silver	Crow Wing	August 6
Elm spanworm *Ennomos subsignaria*	Maple, silver	Crow Wing	July 24
Maple bladder gall mite *Vasates quadripedes*	Maple, silver	Crow Wing	June 4
Ugly nest caterpillar *Archips cerasivoranus*	Maple, sugar Cherry	Beltrami (maple) Cook (cherry)	August 20 in Beltrami; scattered locations throughout Region 2
Mountain ash sawfly *Pristiphora geniculata*	Mountain ash	Region 2	Larvae 0.5" on June 9 in Grand Rapids
Cecropia moth *Hyalophora cecropia*	Oaks	Crow Wing	S9-T44N-R31W on August 9
Rose chafer beetle *Macrodactylus subspinosus*	Oaks	Cass	Causing defoliation of urban oaks on June 11
Walking sticks *Diapheromera femorata*	Oaks (Raspberry)	Crow Wing	S5-T44N-R29W on July 24; less than 30 found
Acorn weevil *Conotrachelus* sp.	Oak, bur	Region 6	August 23
Oak lace bug *Corythucha arcuata*	Oak, red	Region 6	July and August
Kermes scale *Nanokermis pubescens*	Oak, red	Crow Wing	SESE S10-T134N-R29W on August 6; causing up to 8" of twig mortality
Oak spider mite *Oligonychus bicolor*	Oak, red	Anoka	July
Dendroctonus beetles *Dendroctonus valens*	Pine, jack	Koochiching	Found on dead jack pine
Pine tortoise scale *Toumeyella parvicornis*	Pine, jack	Crow Wing	Predominantly on roadside pines from 3-8 feet tall; June 5
Redheaded pine sawfly *Neodiprion lecontei*	Pine, jack	Crow Wing Morrison	July 25; observed on few roadside trees for many years: south of Pillager and between Brainerd and Little Falls

PEST	HOST	COUNTY	NOTES
INSECTS			
Pine needle scale *Chionaspis pinifoliae*	Pine, mugho	Crow Wing	August 7
Pine chafer beetle *Anomala oblivia*	Pine, red	Itasca	
Red pine sawfly *Neodiprion nanulus*	Pine, red	Itasca	Hatched on May 14
Pine aphid *Cinara pini*	Pine, white	Crow Wing	On saplings; August 15
White pine weevil *Pissodes strobi*	Pine, white	Lake	Chip cocoons and larvae on June 27
Eriophytid mites *Eriophyses padi* or *Eriophyses emarginata*	Plum	Crow Wing	June 3
Willow leaf beetle *Plagiodera versicolora*	Poplars and willows	Region 6	August and September
Pitch mass borer *Synanthedon pini*	Spruce, white/blue	Crow Wing	On yard trees in July
Sumac sawflies Unknown spp.	Sumac	Morrison	
Larch sawfly *Pristiophora geniculata*	Tamarack	Clearwater Pine	Clearwater: caused light to moderate defoliation in 1 stand Pine: S-21-T42N-R17W; caused 50% defoliation of few trees which refoliated by end of summer
DISEASES			
Coccomyces leaf spot *Blumeriella jaapii*	Almond, dwarf	Crow Wing	S21-T44N-R30W; August 7
Gall rust *Endocronartium harknessii*	Pine, jack	St. Louis	Sporulating on May 23
Cytospora canker *Valsa kunzei*	Spruce, blue Spruce, white	Blue:Ramsey Washington White:Pine	White: June 28
Wetwood	Birch, paper	Hubbard	Yard trees

PEST	HOST	COUNTY	NOTES
ANIMAL			
Porcupine	Pine, red	Hubbard	Top kill in plantation in S21-T142N-R32W on 12-15 foot tall trees; August
ABIOTICS			
Ash dieback	Ash, green	Region 5	Combination of winter injury and past drought stress; occurred mostly to urban trees.
Maple decline	Maple, sugar	Fillmore	Boulevard trees in Chatfield were in advance stages of decline
Iron chlorosis	Oak, pin	Ramsey	University of Minnesota campus; evident in July
Walnut dieback	Walnut, black	Fillmore	Serious winter damage to 1 stand

PHENOLOGICAL SUMMARY

✔ APRIL

26: FTC Hatching - 493 ° Days (Bemidji)

✔ MAY

14: BB Laying Eggs/JP Sawfly Feeding
17: FTC 3rd Instar
20: Birch Leaf Miner Laying Eggs
23: SBW 0.25-0.38"

✔ JUNE

3: FTC Beginning to Spin Cocoons
9: BB Pupating
12: SBW Pupated
27: FTC Moths Emerged

✔ JULY

22: Aspen Webworm Defoliating Aspen

✔ AUGUST

9: White Pine Weevil Pupating

✔ SEPTEMBER

23: Boxelder bug invasion

DATE	EVENT	LOCATION/COUNTY
	APRIL	
2	1. Willow catkins breaking; 2. 228 ° days (>32°)	1. Cass 2. Bemidji/Beltrami
4	Willows flowering	Grand Rapids/Itasca
6	Record high temperatures. Aspen catkins observed; silver maples in town flowering and catkins observed on alder.	Grand Rapids/Itasca
10	Ice out on McKinney Lake	Grand Rapids/Itasca
25	Birch and lilac buds breaking; some green visible on expanding buds.	Grand Rapids/Itasca
26	1. FTC starting to hatch 2. 493 ° days	1. Bemidji/Beltrami; /Ottertail; and International Falls/ Koochiching 2. Bemidji/Beltrami
27	A few aspen leaves are showing.	Bena/Cass
28	About 10% of FTC egg masses have hatched.	Grand Rapids/Itasca
29	1. FTC moving off of egg masses; weather cold/snowy; 557 ° Days. 2. Snowed in afternoon; 22 °F at 10 PM	1. Bemidji/Beltrami 2. Grand Rapids/Itasca
30	Ground was covered with snow in AM; most melted in PM.	Grand Rapids/Itasca
	MAY	
1	1. 567 ° days 2. Rain and light snow 3. Cold and blustery with 0.5-0.75" of snow overnight. Male and female buds starting to swell on a few white spruce. Alder and tamarack buds are just starting to break.	1. Bemidji/Beltrami 2. Grand Rapids/Itasca 3. Cotton/St. Louis
2	Light snow in AM	Grand Rapids/Itasca
3	Bluebird eggs in nest	St. Paul/Ramsey
5	Red oak leaves 0.5" long; red pine buds 1.0" long; cold rain measuring 2.5"	St. Paul/Ramsey
6	Hybrid poplar leaves 1.0"	Metro Region

DATE	EVENT	LOCATION/COUNTY
	MAY	
7	Weather cool, cloudy, and wet; a few white spruce buds beginning to break.	Cotton/St. Louis
8	Two-lined chestnut borer adults active	Metro Region
9	Dandelions in flower	St. Paul/Ramsey
10	1. 677 ° days 2. Male flower buds on balsam fir swollen; some black flies present; red pine starting to candle; gooseberry leaves 0.38 - 0.5"; willow leaves about 0.5-0.75"; tamarack buds open and needles expanding; some male white spruce buds have broken but most still within the bud scales; female white spruce cones 0.33 to 0.5". 3. Jack pine candles 1.5"; elm leaves 1.5"	1. Bemidji/Beltrami 2. Cotton/St. Louis 3. Metro Region
11	Red pine buds 1.5"; bur oak leaves 3"	Metro Region
12	1. Marsh marigolds in bloom 2. Cottonwood leaves 2.0" across; aspen leaves 1.25" across	1. Grand Rapids/Itasca 2. Metro Region
13	1. Temperatures near 80 °F for last 3-4 days 2. Red oak leaves 2.0"; paper birch in flower	1. Grand Rapids/Itasca 2. Metro Region
14	1. 834 ° days 2. Adult bark beetles constructing egg laying galleries on jack pine; jack pine sawfly eggs hatched and small larvae feeding on needles; red berried elder and hoary puccoon starting to bloom; juneberry and pin cherry in bloom. 3. Red pine sawflies: hatched and feeding on red pine; crab apples starting to bloom. 4. White spruce in Cotton seed orchard sprayed for cone insects and diseases; cones 1.0-1.5", upright, open, and bud caps off; earliest male cones shedding pollen; dandelions blooming; seeds forming on red maple; aspen leaves 0.75-1.0"; gooseberry leaves about 0.75"; black spruce female flower buds just broken; paper birch and cherry flowering. 5. Aspen leaves nearly full-sized; jack pine candles 3"; marsh marigold bloom nearly done 6. Jack pine pollinating	1. Bemidji/Beltrami 2. Big Falls/Koochiching 3. Grand Rapids/Itasca 4. Cotton/St. Louis 5. /Wadena 6. Metro Region

DATE	EVENT	LOCATION/COUNTY
	MAY	
14 (cont)	Aspen fluff (seeds) in air; oak leaves mostly 1" with some 3-4"; big tooth aspen leaves expanding; jack pine candles 1-3"; no growth on red or white pines; pussy toes, dandelions, pin cherries, wild plum, shadbush, *Anemone*, and high bush cranberry in bloom; crab apples just showing color in buds.	/Cass and Crow Wing
15	Lilacs in bloom	Metro Region
16	1. White spruce cones all upright and bracts open; male cones shedding pollen; red berried elder starting to bloom; pin cherry in full bloom. 2. Big tooth aspen leaves 2"; jack pine candles 3-4". Crab apples, apples, choke cherry, *Caragena*, large-flowered Trillium, and some lilacs in bloom.	1. Cotton/St. Louis 2. /Crow Wing
17	1. 939 ° days 2. FTC: 3rd instar, 0.4" 3. Cotton grass in bloom 4. Lilacs starting to bloom 5. White spruce vegetative buds starting to elongate, about 0.25"; buds both with and without bud caps; female cones about 1" and mostly upright; some female buds starting to close; raspberry leaves half size; red pine male buds swelling.	1. Bemidji/Beltrami 2. Brookston/St. Louis 3. /Carlton 4. Grand Rapids/Itasca 5. Cotton/St. Louis
20	1. Birch leaf miner: laying eggs 2. Bud caps off most white spruce vegetative shoots; shoots 0.5"; Female cones about 1.5" and starting to turn down; cones both opened and closed; second scheduled pesticide application canceled due to wind. 3. Lilacs in full bloom	1.Duluth/St. Louis 2.Cotton/St. Louis 3. Grand Rapids/Itasca
21	1. 1053 ° days 2. FTC: 1"; basswood leaves fully developed 3. FTC: 3rd - 4th instar, 1"; red pine sawflies 0.38-0.5"; bark beetles making egg laying galleries; some bark beetle eggs hatched and larvae feeding. 4. Jack pine shedding pollen; *Polygala* and yellow rocket in bloom. 5. Ash starting to leaf out; large-flowered Trillium in bloom.	1. Bemidji/Beltrami 2. /Ottertail 3. Grand Rapids/Itasca 4. /Pine 5. /Aitkin

DATE	EVENT	LOCATION/COUNTY
	MAY	
22	1. FTC: 0.5 to 1.5"; larvae actively crawling up trees in search of food; warm, sultry day. 2. Trillium in bloom; big tooth aspen leafing out; mountain ash flower clusters turning white but not blooming; jack pine male cones turning yellow but not releasing pollen. 3. Moccasin flower in bloom.	1. /Ottertail 2. Grand Rapids/Itasca 3. /Aitkin
23	1. 1136 ° days 2. FTC: 3rd-4th instar; black masses of caterpillars seen on trees; wild strawberry starting to bloom. 3. SBW: 0.25-0.38"; needles on balsam fir shoots starting to flair; needles on white spruce shoots tight together and many shoots with bud caps; jack pine gall rust starting to sporulate; lilacs in full bloom; mountain ash starting to bloom. 4. Bog laurel in bloom. 5. Oak catkins fallen; dandelions gone to fluff; lilacs in peak bloom; choke cherry bloom almost over.	1. Bemidji/Beltrami 2. Tower/St. Louis 3. Ely/St. Louis 4. Bear River/St. Louis 5. /Crow Wing
28	Female conelets on white spruce closed and beginning to become pendant.	Cotton/St. Louis
	JUNE	
3	1. 1528 ° days 2. FTC: beginning to spin cocoons	1. Bemidji/Beltrami 2. /Ottertail
6	1. FTC: 4th to early 5th instar; SBW in 5th instar; dogwood and crowfoot in bloom; most fluff gone from dandelions; goatsbeard flower bud formed. 2. Some cottonwood producing fluff; cotton grass blooming; last few flowers on lilac left; mugho pine shedding pollen. 3. Jack pine candles elongated; no needle development.	1. Brookston/St. Louis 2. Cloquet/Carlton 3. /Pine
9	1. 1741 ° days 2. 1st generation bark beetles mostly pupated; some callow adults and larvae present; mountain ash sawfly 0.38-0.62". 3. Jack pine needles elongating; white pine ready to shed pollen; sow thistle blooming; cotton grass shedding seed. 4. Hoary puccoon in bloom. 5. Field daisies, red clover, *Melilotus*, and vetch in bloom.	1. Bemidji/Beltrami 2. Grand Rapids/Itasca 3. /Cass 4. /Crow Wing 5. /Aitkin

DATE	EVENT	LOCATION/COUNTY
	JUNE	
10	Jack pine sawfly 0.5-1.0"	/Koochiching
11	1. FTC: 40% pulling leaves together to pupate; 10% pupated. 2. FTC: 40% pupated; cotton grass finished blooming; buttercup and dogwood in bloom.. 3. Scattered birch browning due to birch leaf miner. 4. Lilacs blooming.	1. Kelly Lake/St. Louis 2. Cotton/St. Louis 3. Grand Rapids/Itasca & Hibbing/St. Louis 4. Kelsey & Meadowland /St. Louis
12	1. 1848 ° days 2. FTC: completed feeding; many cocoons on buildings. 3. FTC: 75% pupae, 25% larvae. 4. SBW: pupated; mostly dark pupae; some moths emerged. 5. SBW: pupated; some moths emerged. 6. Yellowheaded spruce sawfly still feeding.	1. Bemidji/Beltrami 2. /Ottertail 3. Cook/St. Louis 4. Ray/St. Louis 5. Littlefork/Koochiching 6. Kabetogama/St. Louis
17	1. SBW: all pupated; no larvae or moths; mountain ash blooming. 2. SBW: 35% pupae, 65% larvae. 3. SBW: 55% larvae, 45% pupae; birch leaf miner: birch discoloration beginning to show. 4. SBW: 70% pupae, 30% larvae. 5. SBW: 55% pupae, 45% larvae. 6. SBW: mostly adults; a few pupae not emerged.	1. Finland/Lake 2. Bakers Lake, Sawbill Trail/Cook 3. Gust Lake, Sawbill Trail/Cook 4. Two Island Lake/Cook 5. Devil Track Lake/Cook 6. Ely/St. Louis
18	SBW: 55% larvae, 45% pupae.	Jackson Lake Road/Cook
19	Lilac, bridal wreath, mountain ash, buttercup, and hawkweed in bloom.	Grand Marais/Cook
24	1. 2274 ° days 2. FTC: larvae still present but appear sick; most moths emerged. 3. Dogbane, water hemlock, *Diervilla, Thallictrum*, and daisies blooming.	1. Bemidji/Beltrami 2. Grand Rapids/Itasca 3. /Crow Wing
27	1. FTC: moths emerged; few diseased larvae present; SBW: moths emerged and flying. 2. White pine weevil: feeding with some forming chip cocoons.	1. Echo Trail/St. Louis 2. Finland/Lake

DATE	EVENT	LOCATION/COUNTY
	JULY	
2	1. 2555 ° days. 2. Basswood and dogbane in bloom.	1. Bemidji/Beltrami 2. /Crow Wing
3	Oak wilt going visual	Metro Region
8	Pin cherries ripe.	/Crow Wing
18	Two-lined chestnut borer going visual	Metro Region
22	1. 3333 ° days. 2. Aspen webworm: defoliating aspen.	1. Bemidji/Beltrami 2. Goodland/St. Louis
25	1. Choke cherries at their peak. 2. Jerusalem artichoke, sweet white clover, sow thistle, tansy, and *Solidago* blooming.	1. /Morrison 2. /Cass
30	*Liatrus* and purple-flowered aster blooming.	/Pine
	AUGUST	
1	1. 3662 ° days. 2. Orange fall coloration noted on red maples.	1. Bemidji/Beltrami 2. /Crow Wing
6	Red fall coloration noted on red maples.	/Crow Wing
9	1. White pine weevils: some still in pupal stage. 2. Fall color starts on maple.	1. /Koochiching 2. Metro Region
14	*Armillaria* going visual; *Hyphantria cunea* tents forming	Metro Region
17	Bur oak acorns dropping	Metro Region
21	*Datana ministra* larvae maturing	Metro Region
22	Two-lined chestnut borer larvae 1" long	Metro Region
23	Acorn weevils exit bur oak acorns	Metro Region
24	Stressed red pine, fall needle shed	Metro Region
27	1. 4658 ° days. 2. *Helianthus*, Joe-pie-weed just past peak; fall coloration noted for bracken fern, poison ivy, and dogbane.	1. Bemidji/Beltrami 2. Wadena
28	White oak acorns dropping	Metro Region
31	*Nematus ventralis* larvae feeding on poplar	Metro Region

DATE	EVENT	LOCATION/COUNTY
	SEPTEMBER	
16	Boxelder bugs in house; *Tilia* going dormant	Metro Region
17	*Populus tremula erecta* budset	Metro Region
18	Light frost kills morning glories	Metro Region
19	Tomatoes killed by frost	Metro Region
23	Boxelder bugs clustering on house	Metro Region
25	Banded woollybear caterpillars active	Metro Region
26	Spotty color on red oaks	Metro Region
29	White pine starting fall needle shed	Metro Region
30	Fall color on maple starting; fall color in sumac	Metro Region
	OCTOBER	
1	Ash foliage, 50% color	Metro Region
6	Sumac leaves dropping	Metro Region
7	Early ash dropping foliage	Metro Region
8	Late ash coloring	Metro Region

SPECIAL PROJECTS

- ✔ ASPEN LOSS ASSESSMENT STUDY
- ✔ OAK MORTALITY SURVEYS
- ✔ ICE STORM DAMAGE OF MARCH 22 AND BARK BEETLES
- ✔ DEVELOPMENT OF A JACK PINE SAWFLY EGG SURVEY
- ✔ WHITE SPRUCE SEED ORCHARD CONE PEST STUDIES
- ✔ *CYLINDROCLADIUM* ROOT ROT IN NURSERIES: SURVEY RESULTS AND MANAGEMENT RECOMMENDATIONS
- ✔ DETECTION, ASSESSMENT, AND CORRECTION OF HAZARD TREES IN RECREATION AREAS
- ✔ FOREST PEST DIAGNOSTIC SHEETS
- ✔ DATA AUTOMATION OF SURVEY INFORMATION
- ✔ GYPSY MOTH

ASPEN LOSS ASSESSMENT PROJECT

Project Objectives

The project was initiated to develop and test a loss assessment methodology for aspen. Specific objectives for the project were:

- ✔ Develop a loss assessment methodology
- ✔ Evaluate the loss assessment methodology
- ✔ Evaluate the variation in the aspen resource
- ✔ Evaluate the accuracy of FIA data collection
- ✔ Evaluate clonal influence

Project Organization

The project was organized around 4 studies:

1. Variability Study: Plot parameters such as age, height, DBH, cull, and insect/disease incidence were evaluated to determine variability in the aspen resource. This will allow future assessments to be designed to accommodate for the variation.

2. Data Collection Assessment Study: Insect and disease incidence, cull, and merchantable height were evaluated for accuracy. This will allow training refinements for insect and disease identification, provide information to better estimate cull, and provide the North Central FIA Project leaders feedback on the accuracy of estimating merchantable heights and cull.

3. Cull Study: Cull was measured in selected trees through destructive sampling techniques. This will help determine how much aspen wood is being lost to the major pests of aspen as well as increase the ability to predict cull based on external indicators.

4. Clonal Study: This study looked at the effects of clones on insect and disease incidence and amount of cull.

METHODOLOGY

Permanent Forest Inventory Analysis (FIA) plots were used to collect data for the Aspen Loss Assessment Project. Since actual FIA plots cannot be disturbed, new FIA plots were established. These new plots were located in the Aspen-Birch Unit in Koochiching and St. Louis Counties. Plots were established by inventory contractors during early summer of 1989 at a cost of $176.85 per plot.

35 mm color infrared aerial photography was taken of each plot location in May. This was done to try to identify clonal differences using timing of leaf flush. This would allow tree measurements recorded on each plot to be stratified by clone if more than 1 clone existed on a plot.

After inventory contractors established the plots, Insect and Disease Specialists evaluated the plots during the summer and fall of 1989. Evaluation procedures included: (1) rating trees for damage, and (2) destructively sampling aspen.

Trees to be destructively sampled were at least 5.0 " DBH and were randomly selected from the population of all "in" aspen trees on a particular point. This was done for each of the 10 points with the objective of including 1 tree per point and 10 trees per plot.

The trees were felled, and total tree length, length of live crown, and merchantable length were measured. The merchantable portion was bucked into 2 foot sections. Each section was given an external defect rating, and the top cross section of each section was given an internal defect rating. The area of incipient and advanced decay on the top cross sectional face of each section was traced onto acetate. The volume of advanced decay in each section was then calculated, and total tree cull was the sum of the volume of advanced decay in each section.

RESULTS

Thirty new FIA plots were revisited, partially remeasured, and destructively sampled. There were 1,561 trees 1.0 inch and greater DBH measured on the 30 plots. Quaking aspen dominated with 850 trees or 54% of the total. 295 trees were destructively sampled, and 5,189 2-foot sections were evaluated.

Total measured advanced decay (cull) in the 295 destructively sampled aspen amounted to 109.3 cubic feet. The range in total plot cull was zero on a plot with 1 tree sampled to 19.2 cubic feet of cull on a plot with 10 trees sampled.

There were 850 quaking aspen on the 30 plots. 546 or 64% of the aspen were rated as "healthy," and 304 or 36% had a damage code rating other than healthy. 186 of the 304 aspen that had a damage rating other than healthy were rated to white trunk rot (*Phellinus tremulae*), *Hypoxylon* canker (*Hypoxylon mammatum*), or *Saperda* (poplar) borer (*Saperda calcarata.*) 159 trees or 54% of the destructively sampled trees were rated "healthy," and 136 trees or 46% had a damage rating other than healthy. A summary of the ratings follows:

	✔ *Phellinus*	
	ALL ASPEN	SAMPLED ASPEN
Number of trees:	69	41
% of aspen with defects:	23 %	30 %
% of all aspen sampled:	8 %	14 %
	✔ *Hypoxylon*	
Number of trees:	44	28
% of aspen with defects:	14 %	29 %
% of all aspen sampled:	5 %	9 %
	✔ *Saperda*	
Number of trees:	73	39
% of aspen with defects:	24 %	29 %
% of all aspen sampled:	9 %	13 %

VARIABILITY STUDY

Lowest coefficients of variation were for stand site index (10.9) and plot site index (11.1). Stand or plot parameters with low CV's also included average plot DBH, stand age, and plot age. Using a 95% confidence interval and a 20% allowable error, all of these parameters could be sampled accurately using less than the 30 plots used in this study. Total plot volume would have required 45 plots, and total plot cull volume would have required 195 plots.

Individual tree parameters were similar. Total height had the lowest CV (16.2) followed by crown length (27.8), dbh (33.3), and merchantable length (34.4). Tree volume was slightly higher (73.8), and cull volume was very high (253.6). With this high of variation in cull volume, it would take a sample of 644 trees to get within the 20% level of error.

DATA COLLECTION ASSESSMENT STUDY

Damage Ratings

Table 1 lists the damage categories, also referred to as "damage codes" and/or "insect and disease incidence," the numbers of trees the Specialists coded to a particular damage category, the numbers of contractor codes that were correct ("correct codes"), the numbers of contractor codes that were incorrect ("incorrect codes"), and the numbers of times the contractors missed codes ("missed codes").

The "correct code" category includes a count of all trees where the damage code assigned by both the I&D Specialists and the Inventory Contractors agreed.

The "incorrect code" category is a count of the number of trees that the Contractors coded to the particular damage code, but the I&D Specialists coded the damage to another damage code. For example if a Contractor coded the damage code as healthy but missed a *Phellinus* conk, the I&D Specialist would have coded the damage to *Phellinus*, and the Contractor code would have been incorrect. The total number of trees assigned to a particular code by the Contractors can be derived by adding the number of correct codes plus the number of incorrect codes.

The "missed code" category is a count of the number of trees the I&D Specialist coded to a particular damage code, but the Contractors coded to another damage category. In essence, the contractor "missed" the code. This number is derived by subtracting the number of Contractors' trees for a particular damage category from the number of trees the Specialists identified as being coded to the particular damage code. Essentially, there is overlap in the "incorrect" and "missed" categories. The incorrect category actually compares codes per tree. The missed category is the results of category totals. Obviously missed codes are incorrect codes.

Table 1: Specialist VS Contractor Damage Codes

DAMAGE	# SPEC CODES	# CORRECT CODES	# INCORRECT CODES	# MISSED CODES
		CONTRACTOR CODES		
healthy	1,008	797	130	81
unknown insects	0	0	1	--
borers	63	2	1	60
defoliators	5	5	28	0
budworm	0	0	80	--
forest tent catp.	23	14	50	9
disease/knwn	4	0	0	4
disease/unknwn	0	0	5	---
heart rot	126	59	19	48
Phellinus	68	36	2	30
Phellinus/Hypox	1	0	2	--
Hypoxylon	44	24	57	20
Hypox/Phellinus	1	0	4	---
other cankers	22	13	67	9
stem rusts	1	0	0	1
WP blister rust	2	1	0	1
root rots	3	0	0	3
Nectria	5	0	0	5
Eutypella	0	0	7	---
fire damage	0	0	1	---
animal	1	0	0	1

Table 1: Specialist VS Contractor Damage Codes (Continued)

DAMAGE	# SPEC CODES	# CORRECT CODES	# INCORRECT CODES	# MISSED CODES
		CONTRACTOR CODES		
deer/moose	6	1	0	5
sapsucker	13	6	1	6
mouse	0	0	1	---
weather	1	0	2	---
wind	10	5	4	1
frost crack	66	49	30	---
hail	17	0	0	17
suppression	11	3	1	7
unknown	2	0	2	0
miss/dead top	23	9	5	9
poor form	3	1	20	---
declines	9	3	5	1
other/knwn	13	0	1	12
logging	10	4	1	5
no code	0	2	0	---
TOTAL	1,561	1,034	527	335

Some differences warrant comments:

✔ "Defoliators" and "forest tent caterpillar (FTC)" categories differed noticeably from the Specialists' calls. Plots were located in heavy FTC defoliated areas and were established during the peak defoliation period. When the specialists evaluated the plots, aspen had refoliated. Specialists were also reluctant to code defoliators since defoliation is so transient. If

almost any other factor was present, the tree was given another damage rating. Defoliators were coded only as a last resort.

✔ "Budworms" category was overused. On some plots it seemed that balsam fir received an automatic budworm code. The Specialists did not inspect a single balsam fir that showed budworm feeding damage. The abundant use of the budworms category may reflect the training emphasis for crews that will be working in northeastern Minnesota.

✔ The borer category was exclusively omitted from the Contractors' codes while the *Hypoxylon* code was overused. *Hypoxylon* canker is emphasized during training while *Saperda* borer is not emphasized.

✔ *Hypoxylon* canker incidence was either used too much or not enough. On some plots it seemed the contractor called anything *Hypoxylon* that looked unusual on the tree. On other plots *Hypoxylon* was missed. Generally this canker occurred high in the tree, in the live crown, and it took time to look up into the crown from all sides to find the canker. Because of its location on the tree, it is easily overlooked. However, if one is particularly conscious of *Hypoxylon*, it is easy to call any unusual color high on the trunk, *Hypoxylon.*

✔ There was a high percentage of the *Phellinus* calls that were correct. This would be expected since *Phellinus* conks were the main identifier, and conks are one of the easier items to pick out when assessing damage. Also, during training, *Phellinus* decay of aspen is emphasized. However, given these things, it is surprising and somewhat disturbing that the Contractors missed 30 *Phellinus* calls, and incorrectly identified 2 *Phellinus* calls. Most of the misses involved small conks (less than 1 inch in width) at bases of branch stubs that were overlooked. These were generally on the side of the tree facing away from the point center, but they were within 5 feet of the ground.

✔ The heartrot category, too, showed some wide differences between Specialists' calls and Contractors' calls. This category was more of a judgement call since conks do not necessarily have to be present. Other external signs of internal decay were used. The most common one was an open crack that was oozing or had visibly decayed wood. The frost crack category was often used by the Contractors; whereas, the Specialists used the heartrot category when it was judged that there was a very great likelihood that decayed wood was associated with the frost crack.

✔ Frost cracks tended to be picked up because they were obvious, but then in some cases, more serious damage was overlooked.

✔ The category "other cankers" was probably over used. Whenever there was something different (often a superficial color pattern) some contractors would use this code.

✔ The poor form category was strictly a judgement call. Specialists tended to use this category very sparingly. It seemed that for some Contractors, an assignment of a damage code to all trees on the plot was a necessity. The poor form category may have been overused when nothing else fit just to be able to assign a damage code.

Tree Measurements

217 of the 295 trees destructively sampled had estimated heights and estimated cull. Comparing estimated and measured merchantable heights of these 217 trees:

Estimate = Measured

✔ 11 or 5% had the same estimated and measured lengths

* Underestimation

✔ 72 or 33% underestimated in height
✔ ranged between -1 and -18 feet
✔ 54 of 72 or 75%: 1-5 feet underestimated
✔ 312 feet = total feet underestimated

* Overestimation

✔ 134 or 62% overestimated in height
✔ ranged between 1 and 31 feet
✔ 65 of 134 or 49%: 1-5 feet overestimated
✔ 854 feet = total feet overestimated

A t-test of the paired observations, showed a significant difference at the 95% confidence level between measured and estimated merchantable lengths.

Total estimated tree volume of the 217 trees was 1,789.5843 cubic feet while the total measured volume was 1,715.6881 cubic feet. This was an overall overestimation of tree volume by the contractors of 73.8992 cubic feet or 4% of the total measured volume

Comparing measured cull with estimated cull of the 217 trees:

* Estimated = Measured

  - ✔ 41 or 19% had the same estimated and measured cull
  - ✔ all 41 had 0 cull

* Underestimation

  - ✔ 141 or 65% had underestimation of cull
  - ✔ range between -0.0006 and -7.4272 cubic feet
  - ✔ -63.0163 cubic feet: total underestimated cull

* Overestimation

  - ✔ 35 or 16% had overestimation of cull
  - ✔ range between 0.0001 and 6.1265 cubic feet
  - ✔ 27.2224: total overestimated cull

There was a significant difference at the 95% confidence level between estimated and measured cull.

Total measured cull on the 217 trees was 95.5 cubic feet. Total estimated cull was 59.5 cubic feet. The estimated cull was 62% of the measured cull or a 38% reduction. In effect, the underestimation of cull increased estimated usable wood volume by 36 cubic feet.

Combining the effects of overestimating heights and underestimating cull, there was a 7% aspen volume overestimation found in this study. From the 1990 FIA inventory in the Aspen-Birch Unit, the aspen growing stock volume was 1,503,590 thousand cubic feet. A 7% reduction in the volume would equal over 105,000,000 cubic feet or over 800,000 cords.

CULL STUDY

Cull Summaries

The majority of the aspen sampled had little cull (advanced decay)even though 80% of the trees sampled had some measured cull. The greatest amount of individual tree cull was 8.2272 cubic feet. It had a damage code of 210 or *Phellinus tremulae* and had 23 conks. The total volume of the tree was 23.3926 cubic feet. The measured cull accounted for a 35% reduction in tree volume.

The greatest percent reduction in tree volume 40.2%. This tree had a gross volume of 6.0920 cubic feet, and its measured cull was 2.4472 cubic feet. This tree, too, had a 210 damage code and had 16 conks.

These two trees were among the exceptions. Most trees had a volume reduction due to cull of less than 5%. The overall reduction of volume for all 295 trees was 5%. On a plot basis, total plot volume reduction ranged between 0% to 15.9%. There were only 3 plots with cull amounting to over 10% of the total plot volume.

59 trees or 20% of the total aspen sampled had no cull. 158 trees had a damage code of 000 meaning no damage could be found on the tree. These 158 trees accounted for 11.2235 cubic feet of cull or 10% of the total cull on all 295 trees. Obviously, the 59 trees with no cull were not necessarily among those trees with a damage code of 000.

43.8% of the 5,189 sections had no incipient or advanced decay. 1,641 sections or 32% had incipient decay, and 19.9% of the sections had incipient decay, only. 1,755 or 34% of the sections had advanced decay, and 1,099 or 21% had advanced decay, only.

Table 2 summarizes the damage categories assigned to the 295 aspen in the sample.

Table 2

Damage	No. of Trees	Total Tree Vol	Total Cull Vol	Total % Reduc
None	158	956.7	11.2	1%
Phellinus	38	474.8	67.6	14%
Phel/Hypox	2	9.4	1.1	12%
Hypoxylon	26	138.7	5.0	4%
Hypox/Phel	1	6.2	7.6	29%
Heartrot	12	140.6	9.7	7%
Other Canker	1	3.9	0.1	1%
Nectria	1	3.8	0.1	4%
Saperda	38	220.2	2.7	1%
Def/FTC	5	87.7	5.2	6%
Frost Crack	13	131.2	4.8	4%

Column totals may not equal totals in narrative due to rounding off table values.

Every damage category had some measured cull. Except for damage categories involving *Phellinus tremulae*, the reduction in volume ranged from 0.9% for the damage category "other cankers" to 6.9% for the damage category "heartrot." Even the damage category of *Hypoxylon* canker accounted for only a 3.6% reduction in volume. However, some trees were given a *Hypoxylon* canker damage code when cankers occurred beyond the merchantable portion of the tree. In these cases, there would be no cull measured, and therefore cull related to *Hypoxylon* canker may be underestimated.

Volume reduction due to *Phellinus tremulae* either by itself or in combination with *Hypoxylon* canker was much higher than any other damage category. *Phellinus* by itself resulted in a 14.2% reduction in volume. Volume reduction ranged between 12.2% for *Phellinus/Hypoxylon* to 28.5% for

Hypoxylon/Phellinus. These two categories were two combination categories since both of these pathogens commonly occur on aspen, and both are capable of causing severe impacts to aspen. *Phellinus/Hypoxylon* category means that both are present, but *Phellinus* is judged to be making a greater impact. In the other combination category, *Hypoxylon* canker is judged to have the greater impact. It seems in this study, the presence of *Phellinus* had more of a cull impact than the cull associated with the *Hypoxylon* canker.

It was apparent when first inspecting the standing trees and then cutting them, that it is a difficult task to accurately predict internal cull from external appearances. 4,622 sections or 89.1% had no visible external indicators of cull and yet these sections accounted for 52.1680 cubic feet or 48% of the total cull.

Phellinus tremulae conks were reliable indicators of cull. All but 1 section with a conk had measurable decay. That section had a branch socket filled with conk material and occurred on the upper edge of the section. *Phellinus tremulae* conks were found on 3.1% of the sections, and these sections accounted for 35% of the total cull. *Hypoxylon* canker accounted for 1% of the sections and only 2.3% of the cull volume.

The other significant indicator of decay was an open seam. 1.4% of the sections had open seams, and these accounted for 6% of the total volume. Tight seams were less reliable indicators of decay. The number of sections with tight seams was nearly equal to the number of sections with open seams, 73 versus 65. However, the amount of decay was less, 6% versus 2.1%.

Trees with a damage code of 000 (no damage), had an average cull of 0.0710 cubic feet or a 1.2% reduction in volume. *Phellinus tremulae* had an average cull deduction per tree of 1.7795 cubic feet. All other categories had some cull, but the most surprising was the defoliator/forest tent caterpillar categories. These accounted for 1.04952 cubic feet of cull per tree. However, there were only 5 trees, and these trees were very large. In the absence of an FTC outbreak, these trees would have been rated 000. Cull for these categories is very misleading.

Phellinus tremulae Decay

There were 309 conks on 41 trees or 7.5 conks per tree. The numbers of conks per tree ranged between 1 and 23 conks. Conks averaged 1.57 inches in width, and the range of conk widths was 0.25 inches to 10.0 inches. 73 conks or 24% of the conks were less than an inch in width, 157 or 51% were less than 2 inches in width, and 219 or 71% were less than 3 inches in width.

Average conk height was 10.1 feet, and the range was 1.2 feet to 31.0 feet. The heaviest concentration of conks occurred between 3 and 18 feet. The 10-foot section (8 and 10 feet from the ground) had the greatest numbers of conks, 20. The sections immediately below and above the 10-foot section had the second highest number of conks; each had 17 conks.

In all cases, the internal decay column was longer than the area occupied by the conks. The decay column extended on the average 5.0 feet below the lowest most conk and 8.6 feet above the highest conk. Ranges for below conk was 0.2 to 18.5 feet, and ranges above conk was 0.1 to 32.1 feet.

Cull volume in the decay column associated with the conks accounted for 98% of the total cull volume. Cull volume associated with just the conk area accounted for only 68% of the cull volume. This again indicates that the decay column is larger than the area occupied by the conks.

Hypoxylon Canker

There were 30 trees with *Hypoxylon* canker. 13 of the 30 or 43% of the infected trees had cankers beyond the merchantable portion of the bole. This was indicative of the cankers being fairly high on the tree. The average height of the lowest point of the canker margins was 29.9 feet. The range of lower canker margin heights was 14.1 feet to 51.4 feet. Canker lengths averaged 6.8 feet and ranged between 0.7 feet and 25.9 feet. The average percent of the merchantable bole infected with *Hypoxylon* canker was 15%. This range was 1% to 47%.

Cull was associated with 11 of the 17 trees that had a canker on the merchantable portion of the bole. 36% of the total cull for these 11 trees was cull associated with *Hypoxylon* canker. Sections that had *Hypoxylon* canker had extensive cull. Often the entire cross sectional area was cull.

Poplar Borer (*Saperda calcarata*)

There were only 38 trees that were put into the borer damage category, but there were 206 sections that had internal evidences of borer activity and 147 sections that had external evidences of *Saperda* activity.

There was cull associated with borer activity although cull in the form of cavities due to borer galleries was traced but not measured. Sections that had external evidences of *Saperda* activity accounted for 3.0666 cubic feet of cull. Sections with internal signs of *Saperda* activity accounted for 7.4354 cubic feet of cull.

Occasionally trees with flattened, cankered areas that were not *Hypoxylon* canker or *Nectria* canker were encountered. The contractors generally put these trees in the "other cankers" damage category. When the trees were felled and these areas were inspected and cut into, massive borer activity was found. These flattened areas were attributed to the *Saperda* borer.

CLONAL STUDY

Clonal differences could not be differentiated on the photos. This may have been due to the heterogeneous nature of the stands and/or improper timing of the photography. Attempts were made to try to identify clonal differences by visible tree characteristics. Confidence could not be gained in this procedure, and it was abandoned.

CONCLUSIONS AND RECOMMENDATIONS

LOSS ASSESSMENT METHODOLOGY

The pilot project showed that the loss assessment methodology was a workable and doable methodology. Any assessment involving destructive sampling of trees can be a costly assessment from both personnel and dollar aspects. However, destructive sampling is a critical part of any assessment; the information gained by dissecting trees is invaluable and worth the investment.

Travel time between plots and plot hunting time are the two most time consuming variables. A 3-person crew is the most efficiently-sized crew to do the assessment. Two plots can be done by a 3-person crew in an 8-10 hour day if travel and hunting time are not excessive. Measurements of the acetate tracings, however, can easily take 1 person 1-2 days per plot.

Before undertaking this assessment methodology again, the following should be considered:

✔ Do not rely on CSA information, when stratifying stands and assigning plot locations. If possible physically inspect the stand areas where the plots will be located.

✔ Because CSA stand information is not reliable for this type of assessment, each tree should be aged and site indices developed from measurements made on the destructively sampled trees.

✔ Do not use trees on point 11, the fixed radius growth plot, as part of the destructive sample. Merchantable length and cull are not estimated for these trees, estimated vs measured comparisons cannot be made.

✔ Measure the acetate tracings soon after they are produced. Personnel doing the measurements should have spent time on the plots and being involved with the destructive sampling.

✔ Emphasize separating clones on the plot to evaluate the influence of clones on cull.

✔ Develop a more reliable method of determining incipient decay. For this study, incipient decay was identified when wood fibers crushed or separated and chunks of wood pulled away from the face when a tree scribe was drawn across the face. When wood chunks did not come free or wood fibers separated or crushed, even though the face looked "bad," the sections were considered sound. This is a crude technique, and there was not a lot of confidence that incipient calls should be made consistently between personnel and/or between days and times of days.

✔ Determine industry needs before assessing cull. At what point does the wood become unusable to the industry? Can advanced decay (cull) still be used by the industry? Is incipient decay important to the industry?

TRAINING

The study would seem to suggest that contractors do especially well in identifying "healthy trees." However, once the contractor decided a tree fit into a category other than healthy, the percentage of incorrect calls increased. The study also found an underestimation of cull and an overestimation of merchantable lengths. If this is the case for all aspen plots or for all species, inventory estimates of volume may be significantly different than reality. From this study, some things to consider during training: crews:

✔ There should be an increased training emphasis on distinguishing *Saperda* borer activity from *Hypoxylon* canker.

✔ Training should de-emphasize defoliators, and emphasis made to caution inventory crews to look beyond defoliation to look for more serious damage.

✔ More emphasis should be placed on cull estimation. Hopefully, with more analysis of this data, data from Canadian studies, and data from the aspen cull studies now on going in Koochiching County, more accurate cull estimation techniques can be developed.

✔ More attention should be paid to training and monitoring the estimation of merchantable heights.

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OAK MORTALITY SURVEYS

In an effort to quantify and document losses to the oak resource as a result of the severe and prolong drought of 1987 - 1990, an oak mortality survey was carried out. This survey consisted of two parts: data collection from FIA permanent inventory plots, and interpretation of color infrared (CIR) aerial photography of selected counties.

FIA FIELD SURVEY

The objective of this phase of the survey was to use the FIA permanent plots to quantify the magnitude of the oak mortality. More specifically, data collected from FIA plots would be used to estimate the number and volume of dead oak trees per acre per year for both the oak cover type and the oak in all cover types.

Sampling Methods, Training, Plot Selection, and Data Analysis

During the time of the survey, US Forest Service inventory crews were remeasuring FIA plots in the central part of the state. To take advantage of having these crews already collecting data, the Forest Health Unit of the DNR-Forestry Division in cooperation with US Forest Service, State and Private Forestry, Forest Pest Management Unit contracted with the North Central Forest Experiment Station to utilize these crews to collect additional data related to the oak mortality survey. Additional data was collected by slightly altering data collection procedures by these crews.

Altered inventory procedures included the separation of oak mortality into two periods: pre-1988 and 1988-to-present periods. Trees that fell into the latter period and had not died from an obvious non-drought cause were assumed to have died from drought effects which included the interaction of two-line chestnut borer and *Armillaria* root rot.

Training for these inventory crews was conducted by Division of Forestry Forest Health Specialists. Training emphasized how to identify drought caused mortality and dieback, and how to separate drought caused mortality from oak wilt. Crews were already experienced in judging the general time of mortality.

FIA plot remeasurement by the Forest Service crews was limited to central Minnesota counties where there was a large number of plots remaining to be remeasured. FIA remeasurement in much of the rest of the state had been completed by the spring of 1990. Because oak mortality was occurring statewide, Division Of Forestry Forest Health Specialists revisited randomly selected FIA plots that were coded as oak type. On these plots, the oak component was looked at, and mortality was put into the pre or post 1988 categories.

Field data was collected during the leaf on period of June 1 through September 1, 1990.

Results

A total of 360 FIA plots in 24 counties were included in the survey. 42 plots were revisited by Forest Health Specialists, and 318 plots were visited by inventory crews. Counties where plots were located follow.

COUNTY	NO. PLOTS	COUNTY	NO. PLOTS
Aitkin	5	Becker	5
Beltrami	2	Big Stone	1
Cass	5	Chisago	9
Crow Wing	1	Fillmore	6
Goodhue	2	Houston	4
Hubbard	5	Isanti	10
Itasca	5	Kanabec	50
Kittson	25	Lac qui Parle	1
Lyon	1	Marshall	8
Mille Lacs	45	Pine	154
Wabasha	3	Wadena	5
Watonwan	1	Yellow Medicine	3

Data analysis was done by the North Central Forest Experiment Station. During the analysis phase, criteria were developed to include only those plots that had a significant oak component and were located in forested areas. Actual criteria included:

- ✔ Plots had to have at least 10 ft.^{2} of basal area per acre of Oak.
- ✔ Plots had to be sample kind 2, 3, or 6.
- ✔ Plots had to have been located on timberland on the 1977 inventory.
- ✔ Plots had to have been currently located on timberland.

Additional criteria used in the analysis included:

- ✔ Ingrowth trees and removals were not used; trees had to have been present during both the 1977 and 1990 inventories.
- ✔ Expanded values and dbh classes were based on the 1977 inventory.

When these criteria were applied to the 360 plots, 319 plots met all the criteria. Survey results are based on the data from the 319 plots.

The data is summarized into two categories, (1) oaks found in all cover types, and (2) oaks found in the oak cover types. (The second category is a subset of the first category.) The data represents 449,600 acres in the first category (oak in all cover types) and 58,600 acres in the second category (oak in oak cover types.) These acreage figures are based on 1977 acreage expansion factors.

In the oaks-in-all-cover-types category, mortality was 400,000 trees, for trees with a DBH range of 5.0 to 29+ inches. This amounted to 3.8 million cubic feet or 8.5 cubic ft per acre. In cords the loss is 50,000 cords or 0.1 cord per acre. Board foot loss in trees 11.0 inches DBH and greater was 12.1 million board feet or 27 board feet per acre. See Figures 1, 2 and 3.

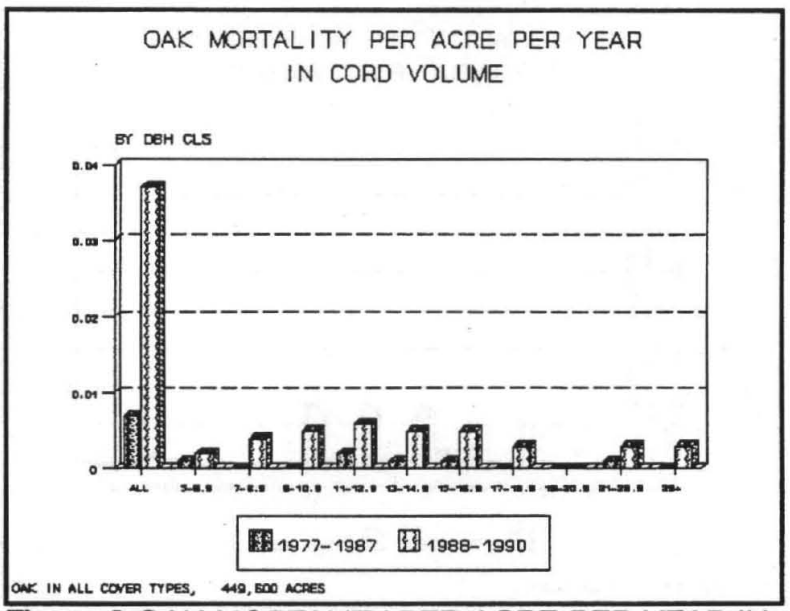


Figure 3 OAK MORTALITY PER ACRE PER YEAR IN CORD VOLUME IN ALL COVER TYPES.

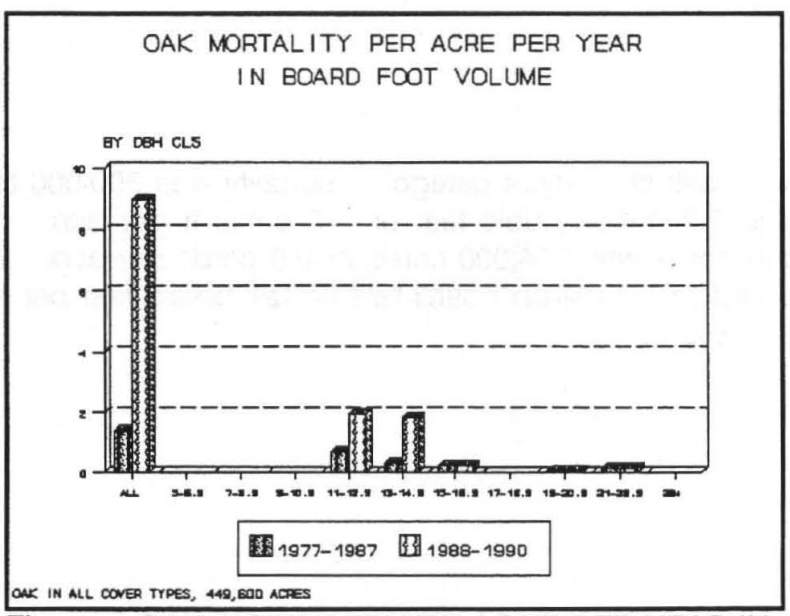


Figure 4 OAK MORTALITY PER ACRE PER YEAR IN BOARD FOOT VOLUME IN ALL COVER TYPES.

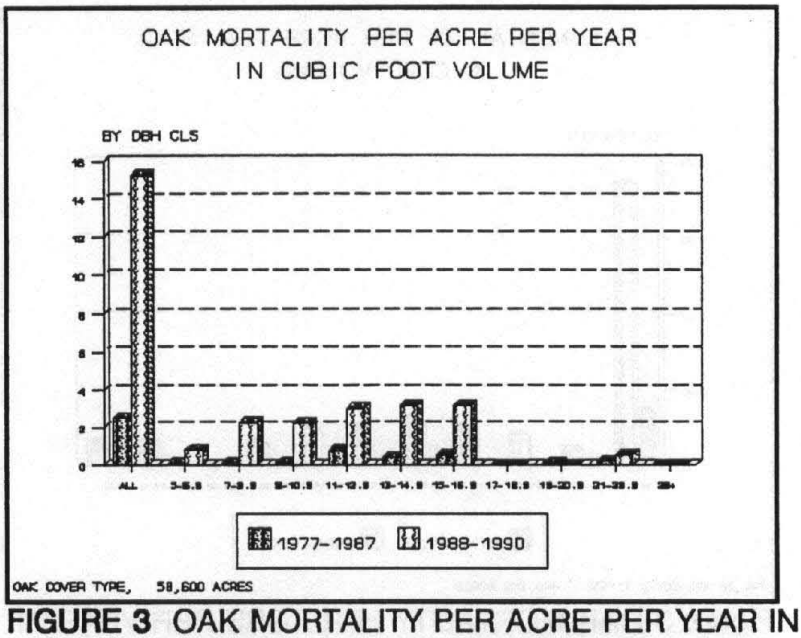


FIGURE 3 OAK MORTALITY PER ACRE PER YEAR IN CUBIC FOOT VOLUME IN ALL COVER TYPES.

In the oaks-in-oak-cover-type category, mortality was 300,000 trees. This loss equaled 2.7 million cubic feet or 45 cubic ft per acre. This loss measured in cords was 314,000 cords or 0.5 cords per acre. Board foot loss amounted to 7.4 million board feet or 127 board feet per acre. See Figures 4, 5, and 6.

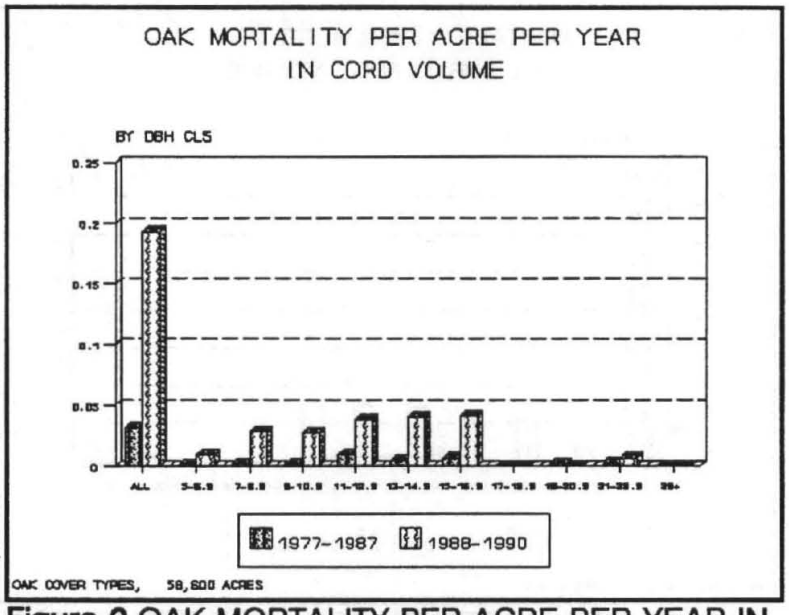


Figure 6 OAK MORTALITY PER ACRE PER YEAR IN CORD VOLUME IN OAK COVER TYPES.

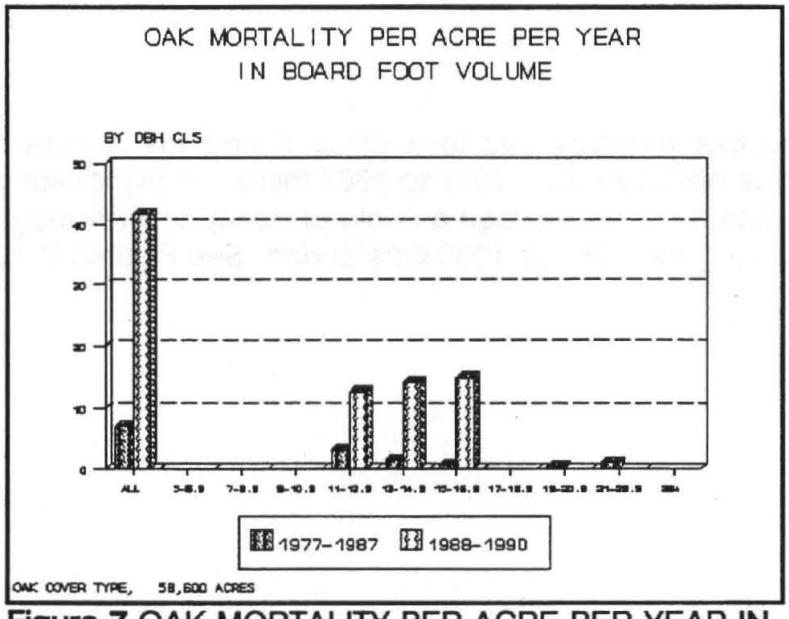


Figure 7 OAK MORTALITY PER ACRE PER YEAR IN BOARD FOOT VOLUME IN OAK COVER TYPES.

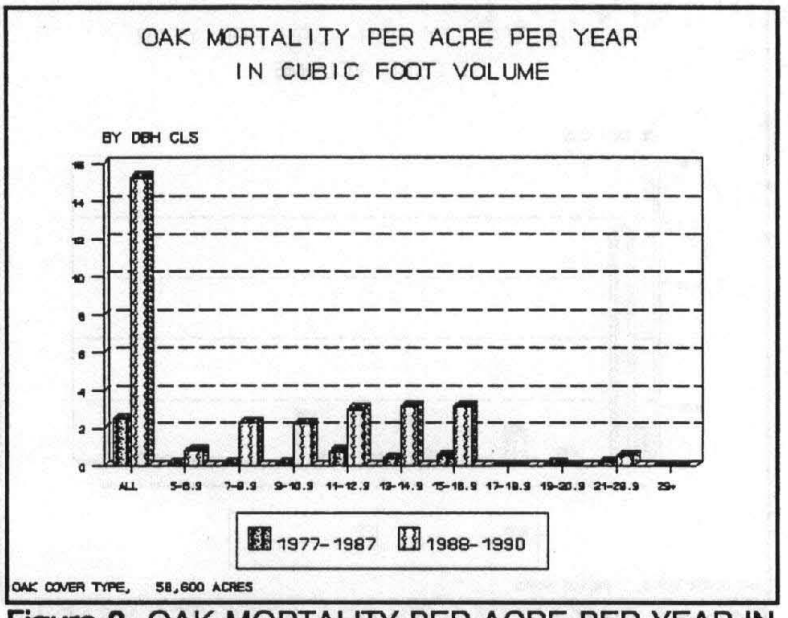


Figure 8 OAK MORTALITY PER ACRE PER YEAR IN CUBIC FOOT VOLUME IN OAK COVER TYPES.

Comparing oak mortality that took place during the current drought to mortality that occurred from 1977 to 1987 there is a significant difference. The data shows on the average a 6-fold or nearly a 500% increase in oak mortality during the 1988 to 1990 time period. See Figures 7, 8, and 9.

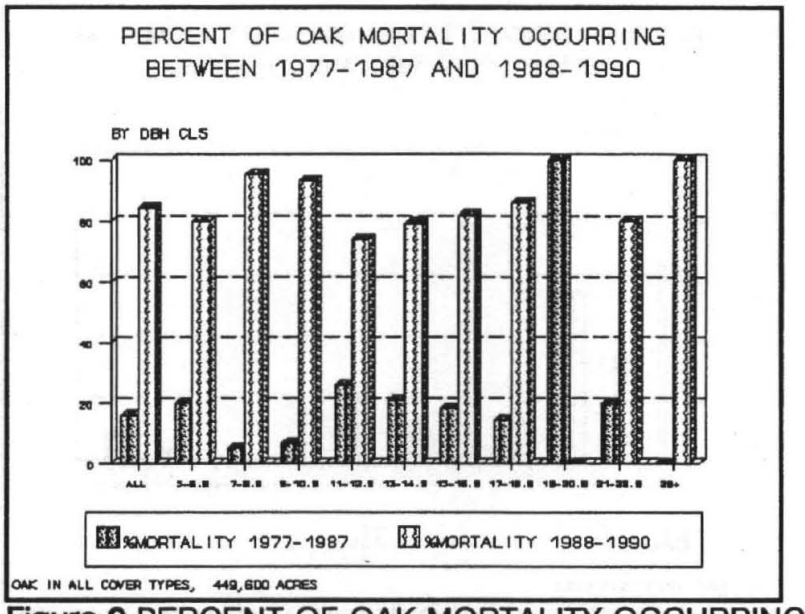


Figure 9 PERCENT OF OAK MORTALITY OCCURRING BETWEEN 1977-1987 AND 1988-1990.

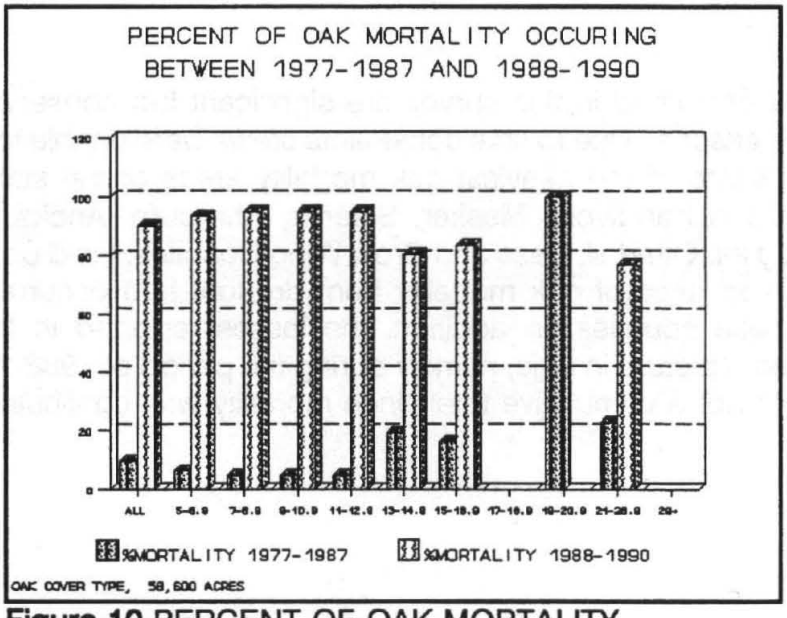


Figure 10 PERCENT OF OAK MORTALITY OCCURRING BETWEEN 1977-1987 AND 1988-1990.

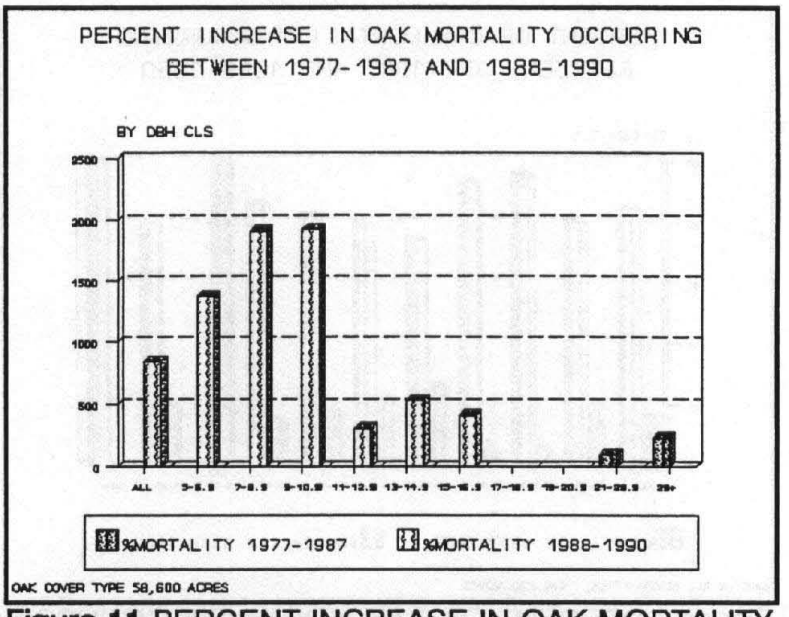


Figure 11 PERCENT INCREASE IN OAK MORTALITY OCCURRING BETWEEN 1977-1987 AND 1988-1990.

The losses estimated in this survey are significant but conservative for a number of reasons. Due to time constraints crews were unable to visit plots located in some of the heaviest oak mortality areas of the state. These areas included Kandiyohi, Meeker, Stearns, Sherburn, Anoka, Morrison, Pope, Douglas, Ottertail, Cass and Crow Wing Counties. Field observations indicated high rates of oak mortality from drought had occurred in all or parts of these counties. In addition, the losses reported in this survey represented a picture in time, namely during the period of 1988-1990. The losses were not a cumulative total since mortality was continuing through 1992.

AERIAL PHOTOGRAPHY SURVEY

On September 1, 1990, 35mm aerial photography using color infrared (CIR) film was taken along four transacts in each of the following counties: Douglas, Stearns, Kanabec, Cass, and Crow Wing. Coverage was non-stereo, and the nominal scale of the transparencies was 1:40,000. The film used was Kodak 2443 Batch 335, exposed through a Tiffen 12 filter and the CC40B filter. Image quality was very good to excellent. The film was developed into slides for interpretation at a projected scale of about 1:1,900. Approximately 1250 slides covering about 7 percent of the gross area in these five counties were obtained.

Stands to be included in the photo interpretation were selected by projecting each slide onto a transect line and including only those stands that intersected the line. Stands were separated by mortality classes and cover type changes. A new stand was identified whenever the mortality class changed or the line was intersected by a forest type other than merchantable-sized upland hardwoods at least 5 acres in size. The selected stands had to be at least 5 acres in size. This corresponded to the minimum stand size for the Cooperative Stand Assessment (CSA) inventory. A grid of 5-acre cells projected adjacent to the transect line aided in determining minimum stand size.

The photo interpretation was done by estimating the percent tree mortality by individual stands of pole-size and larger upland hardwoods. To determine percent tree mortality, individual dead trees were counted within stands. Texture, color, and crown size were used to distinguish tree mortality and cover types. Four mortality classes were chosen to match those of the MN DNR CSA inventory. The classes were:

LOW = 0-10% mortality
MEDIUM = 11-25% mortality
HIGH = 26-50% mortality
EXTREME 51% + mortality

Estimates of percent stand mortality were summarized for all counties combined and for each individual county. This evaluation looked at all oak mortality. No attempt was made to separate 1990 mortality from earlier mortality even though it could be distinguished on the photos.

Results

A summary of the numbers of stands in each county stratified by mortality classes is found in the following table.

Table 3.

Numbers Of Stands						
	Stand Mortality Class					
	LOW	MEDIUM	HIGH	EXTREME		
County	0-10%	11-25%	26-50%	51-80%	80+ %	Total
Cass	399	40	5	0	0	444
Crow Wing	120	1	1	0	0	122
Douglas	62	9	1	0	0	72
Kanabec	193	35	3	0	0	231
Stearns	40	22	8	3	1	74
Total	814	107	18	3	1	943

For comparative purposes, a pre-survey base-line level of stand mortality for these counties was established using the CSA stand data for state lands. Most of the CSA stand mortality estimates were obtained from field observation between 1980 and 1989. A summary of the baseline data can be found in Table 4.

Table 4.

Number Of Stands						
	Stand Mortality Class					
	LOW	MEDIUM	HIGH	EXTREME		
County	0-10%	11-25%	26-50%	51-80%	80+%	Total
Cass	2,186	221	42	3	0	2,452
Crow Wing	511	32	2	0	0	545
Douglas	29	0	0	0	0	29
Kanabec	583	17	4	0	0	604
Stearns	21	0	0	0	0	21
Total	3,330	270	48	3	0	3,651

A mortality class percentage can be calculated by dividing the number of stands in each mortality class by the total number of stands in all classes. When mortality class percentages of the survey are compared to the mortality class percentages of the baseline data, a percent change of the number of the number of stands in each mortality class can be calculated. Percentage change for each class is summarized in Table 5.

Table 5.

PERCENT CHANGE FROM BASELINE TO 1990 SURVEY					
	Stand Mortality Class				
	LOW	MEDIUM	HIGH	EXTREME	
County	0-10%	11-25%	26-50%	51-80%	80+%
Cass	+0.7	0	-0.6	-0.1	---
Crow Wing	+4.6	-5.1	+0.4	---	---
Douglas	-13.9	+12.5	+1.4	---	---
Kanabec	-13.0	+12.4	+0.6	---	---
Stearns	-46.0	+29.7	+10.8	+4.1	+1.4
AVG	-4.9	+3.9	+0.6	+0.2	+0.1

Looking at the average change over the five counties, there was an increase in the percentage of stands falling within the MEDIUM and HIGH mortality classes. There was a 4.9% decrease in the percentage of stands in the LOW mortality class. The majority of this decrease was made up by a 3.9% increase in the number of stands in the MEDIUM mortality class.

Cass and Crow Wing Counties

Survey results indicated no significant change in the distribution of stands by mortality class. However, Cass County differed from Crow Wing County in that two locations in Cass County seemed to have greater mortality than average. Within these two areas the proportion of MEDIUM and HIGH mortality stands increased to 30% and 11% respectively. One of these areas was west of Leech Lake, between Cass Lake and Ten Mile Lake. The other high mortality area was south of Gull Lake.

Douglas and Kanabec Counties

Mortality in these counties increased somewhat from a lower than average pre-survey baseline. The proportion of MEDIUM mortality stands increased to 13 percent in Douglas County and 15 percent in Kanabec County. This does not translate into a great increase in the average stand mortality. Using the midpoints of the mortality classes would translate into an increase of 7% in each mortality class.

Stearns County

Stearns County showed the greatest mortality of all five counties. This is also the county where oak is one of the dominant hardwood species. The MEDIUM and HIGH stand mortality classes increased 30% and 11% respectively. Five percent of the stands sampled were in the EXTREME (51+%) mortality class, and 1 of the stands sampled had greater than 80% mortality.

Stearns County also had a location with much greater mortality than the county as a whole. This area extended for about 2 miles along a flight line south of Birch Lake. County-wide, 30% of the stands fell into the MEDIUM mortality category, 11% fell into the HIGH, and 5% fell into the EXTREME. In the Birch Lake area, 47% were MEDIUM, 15% were HIGH, and 23% were EXTREME.

The pattern of mortality was also unique in Stearns County. Mortality was observed to be significantly grouped or clumped together. These clumps where from 1 to 3 acres in size and were primarily in the EXTREME mortality class.

This report acknowledges the assistance with photo interpretation and report preparation of Dave Aslesen, Special Projects Forester, St. Paul.

For more information, contact: Ed Hayes, (507)285-7144.

MARCH 22ND ICE STORM AND BARK BEETLES

General Andrews State Forest, Gen. Andrews Nursery and a few pine plantations in Jacobson District were hit with a tremendous ice storm on March 22 which caused an estimated $500,000 worth of damage on 4300 forested acres. Conifers, particularly jack pines, were heavily damaged. In some stands more than 50% of the stems were snapped off at 25 feet. More commonly pine and spruce stands had 10- 40% damage with snapped stems, tree tops broken off, trees bent over and branches pulled out. It's estimated that it will take two years to clean up the damage.

The timing of the storm couldn't have been worse. Trees were downed and damaged just in time to season properly for fire season and spring emergence of bark beetles. Moose Lake Area invoked the Incident Command System, calling the incident "Operation Ice Storm". Its purpose was to reduce potential fire and insect hazards in damaged stands and to coordinate salvage in pine stands and debris removal in campgrounds and recreational areas.

Bark beetle management options were discussed with Area, District and Nursery personnel. In Jacobson District, because the acreage was so small, it was decided that piling and burning the downed logs and slash was the best option. In Moose Lake, pine stands were prioritized for salvage and for placement of bark beetle pheromone traps. Bark beetle guidelines were incorporated into all pine sales and salvage operations. Nearly 1120 traps were utilized on 7 high value and high risk sites. See Table 1.

In addition, a public information campaign was initiated to address the large volume of damaged conifers on private lands. An example of the informational releases is found at the end of this section.

A damaging bark beetle population buildup did not occur in the aftermath of the ice storm in Moose Lake. Only 2 generations of beetles developed. Although there was abundant habitat, the indigenous population levels appeared to have been low this spring and the weather was not conducive for a population explosion. This was borne out in the small number of bark beetles actually caught in our pheromone traps. Bark beetles only attacked downed or damaged trees; never live trees. They did not utilize all the "brood" material that they could have, in fact, as much as 50% of the material was unused on damaged trees as of August 14th. See the section

on Bark Beetles for a complete account of their phenology. All the materials damaged in the March storm will be unsuitable for bark beetles by the next growing season.

Table 1.

Bark beetle pheromone trapping in Moose Lake 1991			
Location, Stand #	No. Acres	Trapping Pattern	No. Traps
S2-44-20 #4	22	Grid[1]	180
S19-45-19 #1	37	Barrier[2]	42
S36-45-20 #2,3	131	Barrier	60
S36-45-20 #12,14	10	Barrier	15
S21-45-17 #7,24	104	Grid	520
S16-45-17 #24,30	63	Grid	252
GAS Nursery	NA	Barrier	50

[1] Grid trapping: 4 traps per acre (104 feet between traps).

[2] Barrier trapping: along stand edge with traps 100 feet apart.

Aerial photography in September confirmed that bark beetles were not a problem in the trapped areas.

The bark beetle traps served their purpose. They provided "in place" protection for high value plantations in the event that the population exploded due to a long, dry growing season with abundant habitat.

In Jacobson, the contracted operator did not complete the job and bark beetles did build-up on 1 site. They did not colonize live, standing trees, but did utilize downed logs, snags and slash. A high population is expected next year and the use of bark beetle pheromone traps will be used to control the emerging adult population in the spring and first generation in early June.

For more information, contact: Jana Albers (218)327-4234.

DEVELOPMENT OF A JACK PINE SAWFLY EGG SURVEY

No egg survey exists in Minnesota for predicting the following year's level of defoliation due to the jack pine sawfly. Work was undertaken in 1991 to develop an egg survey for the jack pine sawfly.

Midcrown branches were collected from jack pine on 5 plots in southeastern Koochiching Co. on October 8, 1991. This date was chosen to occur after the sawflies had emerged from the pupal cases in the duff layer and had laid eggs in the jack pine needles. The sawfly overwinters in the egg. The survey methods and data collected are listed below:

SURVEY METHODS

Branch length = 3'
Number of branches per tree = 4
Crown position of branches = mid-crown
Number of trees per plot = 3
Number of branches per plot = 12
Tree class = dominant or co-dominant

DATA COLLECTED

Tree height
Current year defoliation level
Egg colonies per branch
Percent of 1990, 1989 foliage remaining
Infested needles per branch
Eggs per branch
Total number of shoots per sample branch

DEFINITIONS

Sawfly colony - a group of needles, with sawfly eggs, in close proximity to each other.

Shoot - an area of branch with needles extending from a bud to a branch fork or node. (presence of a bud and all needles between it and a branch fork or node)

RESULTS (averages per plot)

	Egg colonies per branch	Infested needles per branch	Eggs per branch	Shoots /brnch
Plot 1 5-65-24 0.08 miles west of milepost 250	1.16	24.5	89.4	37.6
Plot 2 4-65-24 0.4 miles east of milepost 250	0.25	4.41	17.9	42.33
Plot 3 2-65-24 west of milepost 248	0.58	7.83	28.5	73.5
Plot 4 1-65-24 north side of 65 on trail	0.33	6.25	24.6	70.66
Plot 5 7-65-23 south on west boundary road	0.08	1.16	3.8	57
Summary				

COLONY LOCATION ON BRANCH

Total number of colonies on all 5 plots = 29
Number of colonies within 1' of branch tip = 25 = 86.2%
Number of colonies greater than 1' from branch tip = 4 = 13.8%

CONCLUSION

Shorter branches could probably be used since 86% of the eggs were laid within 1 foot of the branch tip. This should be studied in other locations and years before branch length is reduced.

Obviously with no history to go on no definite conclusions can be drawn. However it appears likely that heavy defoliation will occur on Plot 1. Plot 5 will likely have very light defoliation. Weather conditions especially spring weather during and immediately after emergence could affect survival of the sawflies.

For more information, contact: Mike Albers, (218)327-4115

WHITE SPRUCE SEED ORCHARD CONE PEST STUDIES

Insects, diseases and other damages to white spruce cones were monitored and evaluated at the white spruce seed orchard near Cotton, MN in 1991. In 1991, 101.5 bushels of cones were picked and 105.5 lbs. of seed were extracted. In 1990 cones were not picked for seed extraction and the seed orchard was not clean picked for insect control. In 1989, 122 bushels of cones were picked and in 1988, 153 bushels were picked.

A. Cone Rust Incidence

One thousand unsprayed cones were inspected for rust incidence in the seed orchard on June 23, 1991. Fifty cones per tree were examined on 20 trees representing 19 different clones. Cones were rated as infected or not infected. The number of infection pustules per cone was also determined. Results are listed below.

Rust	Incidence
Pucciniastrum americanum (Farl.)	13.5%
Chrysomyxa pirolata (Wint)	O.1%
Total	13.6%

The average number of rust pustules per infected cone = 1.22

B. Cone Insect Incidence

On July 30, 1991, four hundred cones were harvested, cut in half on a cone cutter and inspected to assess the incidence of insect attack. Twenty cones per tree, from each of 20 trees, representing 19 different clones, were examined. Results follow.

PEST	INCIDENCE[1]
All insects	39.7%
Choristoneura fumiferana	4.2%
Coneworms	4.7%
Cydia strobilella	3.5%
Dasineura rachiphaga	9.7%
Hylemya anthracina	25.2%

Overall 60.2% of the cones were not damaged by insects.

[1] Percentages are not additive since some cones were attacked by more than one species of insect.

C. Fungicide Trials

Chlorothalonil was applied using a tractor mounted mist blower as follows:

May 15: Chlorothalonil (Bravo 720) was applied at five pints of product per 100 gallons of water. Twenty five gallons of spray mix were applied per acre. The total amount of Bravo 720 applied was 8.75 pints. Conelets were upright and bracts were open at the time of spraying.

May 28: Chlorothalonil (Bravo 720) was applied at five pints of product per 100 gallons of water. Twenty five gallons of spray mix were applied per acre. The total amount of Bravo 720 applied was 8.75 pints. Conelets were closed and beginning to turn pendant at the time of spraying.

Rows 1 - 9 and 15 - 25 were sprayed. Rows 10 - 14 and 26 - 29 were not sprayed to serve as controls.

On June 23, 1991, 1000 sprayed cones and 1000 unsprayed cones were evaluated for rust infection. Cones were rated as infected or not infected. The number of rust pustules per cone was also

determined. Fifty cones per tree were examined on 20 sprayed trees and on 20 control trees representing 19 different clones. The same clones were sampled in each treatment. Results are:

RUST	INCIDENCE	
	Sprayed	Control
Total rust infection	4.2%	13.6%
P. americanum	4.2%	13.5%
C. pirolata	0.0%	0.1%

Sprayed cones averaged 1.09 rust pustules per infected cone. Control cones averaged 1.22 rust pustules per infected cone.

Chlorothalonil appears to have been effective in reducing the incidence of rust infected cones.

D: Insecticide Trials

Insecticides were applied to the seed orchard using a tractor mounted mist blower as follows:

May 14: Acephate (Orthene Turf, Tree, and Ornamental Spray) was mixed at one pound of product per 25 gallons of water and applied at a rate of 25 gallons of spray mix per acre. A total of 7 lbs of product was applied. Female conelets were upright, open and pollen was being released at the time of spraying. Based on recommendations from Willard Fogal (Petawawa) this application was late.

May 28: Dimethoate (Cygon 400) was mixed at 1.4 gallons of product per 100 gallons of water and was applied at a rate of 25 gallons of spray mix per acre. A total of 2.4 gallons of Cygon 400 was applied. Female conelets were closed and beginning to turn pendant at the time of spraying.

Rows 1 - 9 and 15 - 25 were sprayed. Rows 10 - 14 and 26 - 29 were not sprayed as controls.

On July 30, 1991, 400 sprayed cones and 400 unsprayed cones were collected and stored in a refrigerator. Within two weeks of collection the cones were cut in half and inspected to assess the incidence of insect attack. Twenty cones per tree from 20 sprayed trees and from 20 unsprayed trees representing 19 different clones were examined. The same clones were included in the sprayed and control samples to allow for any differences in genetics that may exist. Results are listed below.

INSECT PEST	INCIDENCE	
	Sprayed	Control
Choristoneura fumiferana	3.7%	4.2%
Coneworms	0.5%	4.7%
Cydia strobilella	0.75%	3.5%
Dasineura rachiphaga	12.5%	9.7%
Hylema anthracina	1.7%	25.2%
Mayetiola	0.75%	0.0%
Total insect damage[1]	19.2%	39.7%

[1]Percentages are not additive since some cones were attacked by more than one species of insect.

The insecticide treatments appear to have been effective in reducing damage by coneworms, *C. strobilella* and *H. anthracina*. *Dasineura* was not reduced by the insecticide treatment. However *Dasineura* while being fairly abundant does not cause significant cone damage or seed loss.

E. Overall cone rating

When cones were dissected and examined, they were also rated as "good" or "no good". To be rated as "good", more than 50% of the seed must appear sound. Overall 75.5% of the control (unsprayed) cones were rated as good, while 98.2% of the insecticide sprayed cones were rated as good.

PHENOLOGY

May 1:	Cold and blustery with 1/2 to 3/4 inches of snow overnight. Male and female buds starting to swell on a few trees. Alder and tamarack buds are just starting to break in the Cotton seed orchard; Cotton, St Louis Co.
May 7:	Weather has been cool, cloudy and wet. Still only a few male and female buds are beginning to break; Cotton, St Louis Co.
May 10:	Male flower buds on balsam fir are swollen. Some black flies are present. Red pine are starting to candle. Gooseberry leaves are about 3/8 to 1/2 inch long and willow leaves are about 1/2 to 3/4 inches long. Tamarack buds are open and needles are expanding. Some male white spruce buds have broken but most are still within the bud scales. Female white spruce cones are 1/3 to 1/2 inches.
May 12:	Marsh marigolds in bloom; Grand Rapids, Itasca Co.
May 13:	Temperatures have been near 80 degrees F for last 3 to 4 days; Grand Rapids, Itasca Co.
May 14:	Crab apples are starting to bloom. Red pine sawflies have hatched and started feeding on red pine; Grand Rapids, Itasca Co.
May 14:	White spruce in Cotton seed orchard sprayed for cone insects. Cones are 1 to 1.5 inches long upright, open and bud caps are off. The earliest male cones are shedding pollen. Dandelions are blooming, seed is forming on red maple, aspen leaves are about 3/4 to 1 inch long, gooseberry leaves are about 3/4 inches long, and black spruce female flower buds have just broken. White birch and cherry are flowering; Cotton, St Louis Co.
May 14:	Oaks starting to leaf out; Grand Rapids, Itasca Co.
May 15:	White spruce in Cotton seed orchard sprayed for cone rusts; Cotton, St Louis Co.

PHENOLOGY (Continued)

May 16: Red berried elder is just starting to bloom and pin cherry is in full bloom. White spruce cones in the Cotton seed orchard are all upright and bracts are open. The male cones are shedding pollen; Cotton, St Louis Co.

May 17: Lilacs starting to bloom; Grand Rapids, Itasca Co.

May 17: Vegetative buds on white spruce have started to elongate about 0.25 inches and some still have bud caps on and others have lost the bud caps. Female cones are about 1 inch long and are still upright but some have started to close. Raspberry leaves are about half size and red pine male buds are swelling. Cotton, St Louis Co.

May 20: Bud caps are off most vegetative shoots on white spruce and shoots have elongated about 1/2 inch. Female cones are about 1.5 inches long and the first ones have just started to turn down. Some cones are still open and others have closed. The second pesticide application planned for today was postponed due to wind and was rescheduled for May 22. Cotton, St Louis Co.

May 20: Lilacs in full bloom; Grand Rapids, Itasca Co.

May 28: White spruce in Cotton seed orchard sprayed for cone insects and diseases. Female conelets on white spruce are closed and beginning to turn pendant; Cotton, St Louis Co.

For more information, contact: Mike Albers, (218)327-4115

Cylindrocladium ROOT ROT IN NURSERIES
SURVEY RESULTS
MANAGEMENT RECOMMENDATIONS

Fungi in the genus *Cylindrocladium* are important pathogens of conifer seedlings and transplants in many nurseries in the Midwest and Ontario. Although they primarily cause root rot, other disease symptoms such as, damping off, needle blight and stem cankers, are commonly observed.

The fungus overwinters in infected conifer tissues or in the soil as thick-walled structures called microsclerotia. These structures can survive long periods of time in the soil. At the Kimberly-Clark nursery site, it can still be found 15 years after conifers were last grown there. Because it survives long periods of time in soil and plant debris, nurseries and planting sites can readily become infected since *Cylindrocladium* can be easily transported between nurseries and between nursery and planting sites.

This particular root rot is of concern to nursery managers and foresters alike because it can cause serious economic losses in both nurseries and outplantings. It has particular potential to be an economic problem in the Lake States because it has been found in all other government owned nurseries and in some industrial nurseries.

In 1976, Dr. French of the University of Minnesota reported the loss of 80% of all seedlings at the Kimberly-Clark nursery in Two Harbors. The value of this loss amounted to $40,000. The same report documented that the nursery was subsequently closed as a result of the root rot infestation. In Ontario during 1988, the losses from 6 surveyed compartments in five nurseries was $150 per 1000 trees for a total of $65,000. Their latest reports indicate that the root rot problem seems to be building.

In 1974, *Cylindrocladium* was diagnosed only at Midhurst Nursery in Ontario. By 1986, Canadian researchers had documented its spread to the eight of ten provincial nurseries via infested soil and on infected transplants. The fungus is at low levels in their northern nurseries but at damaging levels in the southern nurseries. As another example, Potlatch nursery transplanted some of the Kimberly-Clark's red pine seedlings into their nursery, thus infesting their soil. Since then, root rot has been

observed at Potlatch, and *Cylindrocladium* sp. diagnosed as the causal agent.

Cylindrocladium does have an impact on outplanting success. MacGauley (Ontario) found that 21% mortality occurred in the first 4 months of outplanting. These trees had passed grading criteria for height, stem diameter and good color. Higher rates were found in ungraded seedlings in Wisconsin by Dr. Patton. 41% of the red pine transplants died in the first year, and an additional 19% died during the second year.

1962 was the last time a thorough investigation was made for *Cylindrocladium* sp. at General Andrews and Badoura State Nurseries. Since that time, there have not been reports of severe root rot problems or losses. Was this due to low levels of the fungus or was it because we do not have the fungus in our nursery beds? At two meetings with Nursery and Tree Improvement managers, the implications of the problem were discussed and a limited survey was planned for the fall of 1991. Only the beds where "outside" seedlings had been stored or where "outside" equipment from a known contaminated nursery had been used were to be sampled.

A total of 48 soil samples were taken from E4, C7 and the shadehouse at GASN and D3 and D4 at Badoura Nursery. We followed the Ontario Ministry of Natural Resources' procedures for field sampling and lab quantification. The Plant Disease Clinic at the University of Minnesota processed the samples for a fee of $2000. No *Cylindrocladium* species were found.

Guidelines, ideas and recommendations were developed to prevent the introduction of the disease and mitigate its spread. They will work for other soil-borne pests, too, so they have broader applicability than just for *Cylindrocladium* root rot.

Cylindrocladium ROOT ROT MANAGEMENT RECOMMENDATIONS MINNESOTA DNR NURSERIES and TREE IMPROVEMENT PROGRAM

GENERAL

1. A guideline was developed that states "under no circumstances will rooted trees or shrubs or soil from an outside nursery be introduced into production beds or areas that are not isolated to prevent nursery bed contamination." This would include transplanting stock from one state nursery into another state nursery.

2. Do not borrow or lend equipment between nurseries unless they are thoroughly washed with high pressure water to remove all dirt, roots, etc. from the equipment. Washing should be done in an area where nursery beds won't be contaminated. Equipment should be washed before it leaves a nursery and after it returns.

3. Never accept returned materials at the packing buildings, nursery beds,etc. Take them directly to the disposal site and burn or bury them.

4. Keep seedlings as unstressed as possible. Avoid water deficits, herbicide damage and pest problems.

5. Minimize transplanting.

6. Advocate local testing and *Cylindrocladium* root rot research:

    a. Conduct limited testing each year.
    b. What cover crops and fumigants decrease its occurrence?

7. Choose a dump location well away from production beds. Use dumpsters near each building that have seedlings, soil or debris in them.

8. Don't use green dump material for mulch or fill near production beds.

FOR POSSIBLE INFESTED SOILS IN PRODUCTION AREAS

1. Always fumigate between crops in contaminated beds.

2. Use cover crops that don't increase root rot occurrence, or don't use cover crops at all.

3. Use high pressure washing of wheels, tracks, blades, etc. that are in contact with the soil BEFORE going to another bed to remove all soil, debris, roots, etc.

4. At lifting, be especially careful not to transport seedlings and soil onto other beds. For example, empty debris from tubs, sweep out hauling truck, brush off knee pads and clothing, and wash off vehicle tires and blades.

5. Minimize both machinery and people traffic through these beds.

6. Put up "sweep and wash equipment" signs on contaminated beds, and enforce this rule.

7. If no portable high pressure water spraying unit is available, wash the equipment at the pesticide washing station or in a location where beds will not be contaminated.

8. Don't transfer or transplant stock from these beds to any other areas.

PACKING SHEDS AND COOLERS

1. Dispose of discarded seedlings, floor sweepings, etc. in the dumpster. Do this at least every day the buildings are used.

2. When stock comes from either another nursery for repackaging or from a contaminated bed, wash or sweep the entire shed after packing is done. Include hands, gloves and boots in the clean-up.

3. Do not reuse paper liners in packing crates.

ROOT CELLARS

1. Do not reuse moss, soil or organic materials for packing.

2. Sweep root cellars clear of soil and debris each spring and fall.

TRANSPLANT STOCK AND CONTAINERIZED STOCK

1. Do not plant outside source transplant stock into production beds.

2. Do not store containers or containerized stock on beds or where water can runoff and get onto production beds.

3. For breeding or grafting work:

   a. Import only scion, non-rooted or soil-less material when possible. Have materials inspected at the source for diseases including *Cylindrocladium* root rot.

   b. Never plant rooted transplants into production beds. Use the greenhouse or shadehouse with potted plants instead.

   c. Develop an area where only outside transplants are planted that is well away from the production beds. Use sanitary practices on equipment and boots.

GREENHOUSE AND SHADEHOUSE

1. Good sanitation practices are critical in keeping *Cylindrocladium* root rot out of the production beds. The best source for this organism is in potentially infected seedlings and infested soil from outside nurseries. Caution and good judgement should be used when dealing with these materials.

2. When using any outside stock, use plastic liners on benches to contain the potential contamination. Dispose of all pots, debris, excess water and the liner itself when the crop is done.

3. Use a benomyl root dip on all outside rootstock.

4. Boots could be cleaned off before and after working in either house.

5. For the shadehouse, ensure rainfall doesn't runoff to nearby production beds. Perhaps berm the perimeter and use gravel as flooring.

EVELETH NURSERY

The Eveleth nursery is infested with *Cylindrocladium* root rot as documented by Dr. N. Anderson in 1962. Management guidelines when MN-DNR Forestry is involved with this nursery:

1. Never transplant stock from Eveleth into production beds.

2. Use Eveleth for all repackaging of outside materials and stocks. Don't open boxed materials at GASN or Badoura that have been opened or repackaged at Eveleth. If boxes are packed at Eveleth, they could be safely stored in coolers at GASN or Badoura if they were not opened or damaged.

3. Use good sanitation practices each day (ie: sweeping, debris disposal, etc.).

For more information, contact Jana Albers, (218)327-4234

HAZARD TREES
DETECTION, ASSESSMENT AND CORRECTION IN RECREATION AREAS

In 1987, the Forest Health Unit began work on developing a hazard tree rating system for use in State Park and State Forest campgrounds. During the four intervening years the system was refined. A Departmental committee was set up to incorporate the rating system into a Department-wide program that involved a hazard tree management policy, a hazard tree manual, and a training plan to uniformly implement the policy.

When developing the hazard tree rating system, the goal was to institute a hazard tree detection and assessment program that was:

- ✔ **Simple**: not difficult to learn or cumbersome to use
- ✔ **Doable**: each Division has sufficient staff and funding to accomplish the recommended level of responsibility
- ✔ **Standardized**: all inspected areas would be rated and corrected similarly
- ✔ **Documented**: all inspections and corrections are documented.
- ✔ **Decentralized**: the local manager has both responsibility and authority for program accomplishments
- ✔ **Focused**: directed at Divisions of Parks and Forestry campgrounds
- ✔ **Resource Preservation**: as many of the old and large trees as possible would be saved.

The rating system is based on individual tree evaluations. Components of the evaluations include:

✔ **TARGETS**: Inspectors look for a potential targets for the tree to fall on.

✔ **DEFECTS:** Inspectors look for the presence of defects or indicators of potential tree failure. Seven categories of defects were identified: cracks, weak branch unions, decay, cankers, dead trees, root problems and poor tree architecture.

✔ **SITE CHARACTERISTICS**: Inspectors look at site characteristics such as history, soils, etc. to help evaluate the potential for tree failure.

✔ **ASSESSMENTS**: Inspectors make tree assessments while they are on site the site. It's not necessary to manipulate numbers or do calculations to arrive at a hazard rating.

✔ **CORRECTIONS**: Inspectors recommend corrective actions while on the site. They are:

1. Move the target
2. Prune the branch(es)
3. Cut the tree down.

On November 12, the Commissioner's Council unanimously approved both the policy and hazard tree manual. The policy is now a MN DNR Operational Order. The manual is entitled, "How To Detect, Assess and Correct Hazard Trees in Recreational Areas."

POLICY

The Department is authorized by law to provide sites for public recreation and to manage these sites for their natural resources. It is the Department's policy to try to provide for reasonable public and employee safety on intensively used recreation sites and administrative sites by detecting and correcting situations involving hazard trees.

This will be accomplished by inspections, maintenance and by corrective actions. On an annual basis, trees in drive-in campsites in developed

campgrounds will be evaluated and corrective actions taken. Every other year, trees in picnic areas, buildings and facilities in developed campgrounds will be evaluated and corrective actions taken. Trees on public water accesses, administrative sites, day-use areas, parking lot peripheries and near buildings will be evaluated less often. For these sites, special trips or visits for the sole purpose of hazard tree inspections do not have to be made. Instead inspections and corrections are done as a part of the regularly scheduled maintenance activities for the sites.

Not covered by this policy are trees along trails, trout streams and forest roads, and trees in old growth/forest areas and "wilderness experience" areas. The document, "How To Detect, Assess and Correct Hazard Trees in Recreational Areas" establishes procedures, standards, schedules and forms to use in detecting and correcting hazard trees.

MANUAL

In addition to the materials described above, the 70 page manual also contains technical information about tree defects and their respective hazard levels, program evaluation guidelines and appendices which provide forms, field guides, technical diagrams and suggestions for further reading. The manual will be loose-leaf format, to accommodate revisions, and will have color photographs depicting tree defects.

PROGRAM IMPLEMENTATION

It will be the responsibility of each Division and Bureau to provide training and funds for implementing and evaluating the hazard tree program. In Forestry, the Recreation Program will incorporate the Op Order and Manual and provide training opportunities. The Forest Health Unit will provide training to Division of Forestry personnel and to personnel from other Divisions who will serve as trainers for their respective Division personnel. Training is scheduled for March of 1992.

For more information, contact Jana Albers, (218)327-4234.

FOREST PEST DIAGNOSTIC SHEETS

As a training aid for FIA inventory crews, "Forest Pest Diagnostic Sheets" consisting of color photos of the FIA damage codes were produced. When the FIA damage codes were revised and standardized in 1990, these sheets needed revision and updating. Ten new sheets were produced to cover the 41 FIA categories that are used in Minnesota. There are 16 photos on the front side of each sheet. On the reverse side is a general description of the category, potential host trees, severity and diagnostic characteristics. A companion slide set for training was also produced.

The sheets were revised with a two-fold purpose in mind, (1) as an aid in FIA training and inventory work, and, (2) as a field guide for MN-DNR Field Station foresters and technicians as well as college and tech school students. This was the final step in a Federally-funded project, Standardization of the FIA Codes, and was supported by the MN Dept. of Agriculture.

For more information and examples of the sheets, contact S. Olin Phillips, (612)296-5965.

DATA AUTOMATION OF SURVEY INFORMATION

The Forest Health Unit began to move its survey maps into digital formats that can be accessed by various Geographic Information Systems (GIS). In order to maintain consistency with existing statewide databases, a set of technical criteria for the data sets was established.

1) All data sets will be georeferenced in accordance with state standard coordinates as maintained and provided by the Land Management Information Center (LMIC), Department of Administration.

2) Digitizing will be via ARC/INFO in meters. Files will be converted to 40 acre cells.

3) Standard file type will be EPPL7 Grid Cells utilizing MILMIS40 protocols. This provides the 40 grid cell format and statewide coverage. There are approximately 1.4 million grid cells in a single file.

4) Each file has an accessory legend file (*.LEG) and count file (*.CNT). These files contain the class description for each base file (*.EPP) and a count of the .EPP file using the classes defined in the .LEG file.

The first data set was released in November, 1991. A listing of the data set and files can be found in Table 1.

This information is supported by files of similar format on soils, landforms, administrative areas (county, DNR areas, etc.), forest covertype, physiography (elevation, slope, aspect, and waters), and cultural features such as roads.

For more information, contact: Tom Eiber, (612) 772-7567.

Table 1.

Map #	Map Name	Contents
1	NORMRAIN	Normal average precipitation for the growing season from May through September in inches.
2	NORMPREC	Normal average precipitation for the year in inches.
3	WP-A27-91	Week's Precipitation for week beginning Aug. 27, 1991
4	NP%-GS91	Precipitation (percent of normal) for the 1991 growing season
5	WPBR-HAZ	White pine blister rust hazard zones as defined by USFS
6	FTC-91	Forest tent caterpillar defoliation in 1991
7	SB-91	Spruce budworm defoliation in 1991
8	NORMTEMP	Average annual temperature
9	FALLTEMP	Normal fall temperatures, September - November
10	WINTTEMP	Normal winter temperatures, December - February
11	SPRTEMP	Normal spring temperatures, March - May
12	SUMMTEMP	Normal summer temperatures, June - August
13	MEASEVAP	Mean measured evapotranspiration, streamflow method
14	THORN	Mean potential evapotranspiration, Thornthwaite method
15	FTC-89	Forest tent caterpillar defoliation in 1989
16	FTC-88	Forest tent caterpillar defoliation in 1988
17	SB-89	Spruce budworm defoliation in 1989
18	SB-88	Spruce budworm defoliation in 1988
19	IPS-88	Ips bark beetle mortality in 1988
20	DROUGHT	Cumulative precipitation departure for 1987 through 1989
21	SB-90	Spruce budworm defoliation in 1990
22	FTC-90	Forest tent caterpillar defoliation in 1990

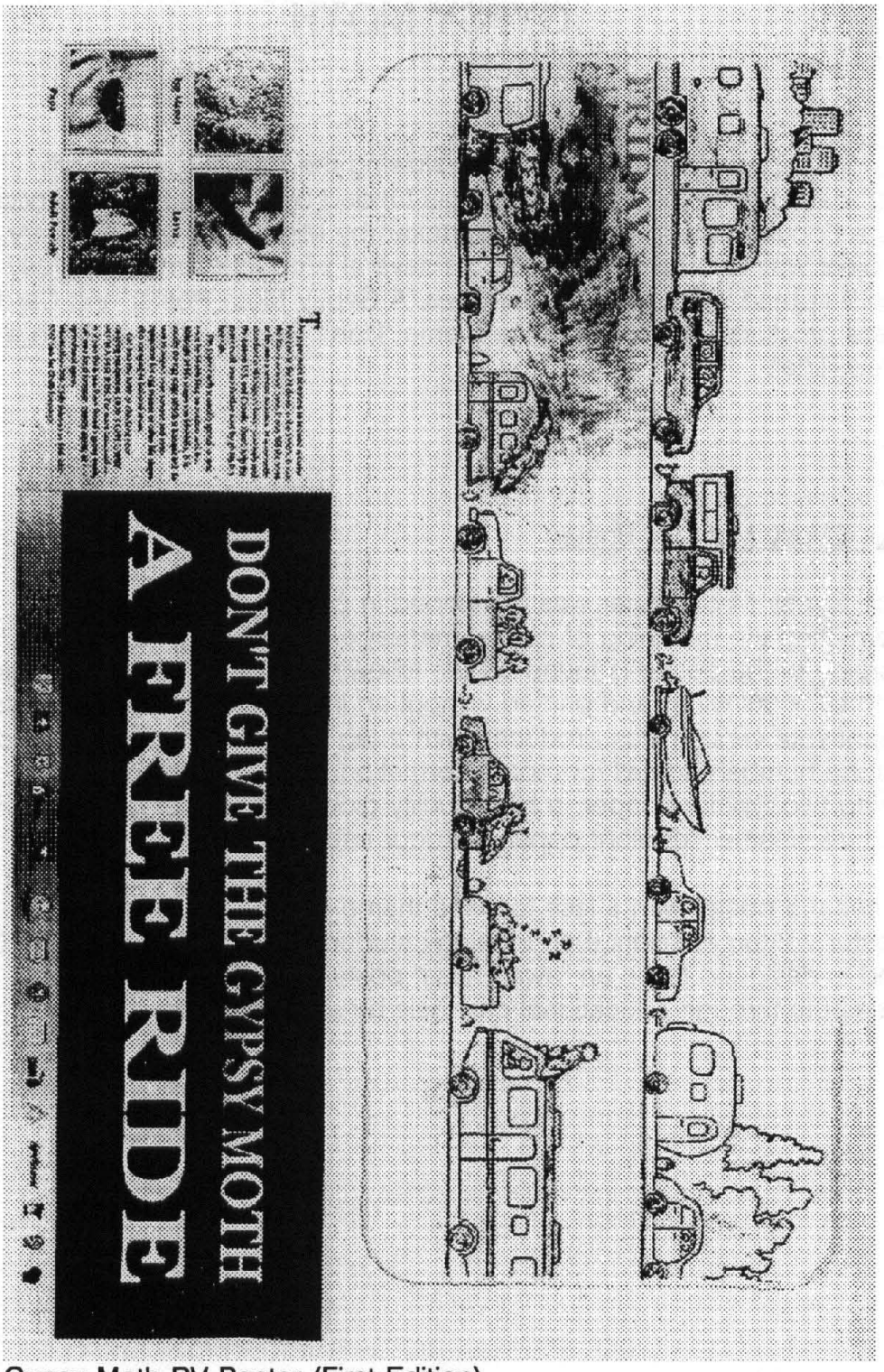
GYPSY MOTH

In 1991, a special project aimed at slowing the rate of gypsy moth introduction into the Lake States was funded by the US Forest Service as a Focus Funding Project. Undertaken by Minnesota DNR-Forestry, the project was to create and distribute several products aimed at gypsy moth spread by recreational vehicles. A Gypsy Moth Poster and Card were produced in 1991 with the theme "Don't Give the Gypsy Moth a Free Ride".

The Gypsy Moth RV Poster

The Gypsy Moth poster was developed in parallel with the card permitting the matching of colors, message, and style. (A reduced version of the poster is found on the following page.) Posters were large (18" tall x 30' wide) and printed without an information tag line. A special Minnesota version was produced with a tag line after the text that had phone numbers to call for more information. Posters were produced using two types of paper; a high quality glossy (indoor use) and a satin texture weather resistant paper (outdoor use).

A second poster with a less focused theme is in design stages. This poster will target science and biology students in grades 7 through 10 and is designed to be an "awareness" poster. It should be ready to distribute through educational channels by early summer.



Gypsy Moth RV Poster (First Edition)

The Gypsy Moth Card

The card is a four panel fold-up design with high quality color photographs printed on a four color press. (See an example of the card on the following page.) The card was designed to be customized by inserting the logo (or two) and information phone number for each state. In the initial printing, the six states (Iowa, Wisconsin, Michigan, Illinois, Missouri, and Minnesota) were joined by the Forest Service in the printing of 250,000 cards. Before printing, Minnesota was contacted by Florida about printing a Florida card. As of January 1, the card is in a second printing with over 300,000 in circulation.

Circulation of the cards was accomplished mainly through campground entrance stations in state parks. In addition, cards were distributed through regional and local forestry offices and were included in with pay checks in several areas of the state. Large numbers of cards have been distributed to Anoka and Hennipen County Parks for distribution in 1992. It is hoped that every camping family will have received a card by the end of the 1992 camping season.

The Gypsy Moth Card. Outside panels at the top, right panel in front cover. Inside panels at the bottom.

SURVEY RESULTS

- ✔ JACK PINE BUDWORM
- ✔ PINE TUSSOCK MOTH
- ✔ JACK PINE SAWFLIES
- ✔ SPRUCE BUDWORM
- ✔ FOREST TENT CATERPILLAR

JACK PINE BUDWORM

REGION 1

LARVAL SURVEY

This survey involved counting the number of shoots that had budworm larvae feeding on them. 30 shoots on branches cut from the mid crown area from 5 trees were inspected at each location. Heavy defoliation is predicted when 20 or more shoots have larvae on them.

BELTRAMI

Description	Count
SENW S05-T147-R34	7/30
NENE S08-T147-R34	15/30
NENE S11-T147-R34	5/30
NWNW S11-T147-R34	17/30
NWNW S24-T147-R34	7/30
SESE S26-T147-R34	6/30
SESE S30-T147-R34	2/30
SENE S35-T147-R34	0/30
NENE S01-T147-R35	13/30
SENW S02-T147-R35	13/30
SWNE S03-T147-R35	0/30
SESE S11-T147-R35	O/30
NENE S13-T147-R35	1/30
NWNW S19-T148-R35	0/30
SESE S19-T148-R35	1/30
NWSE S29-T148-R35	1/30
NWNE S32-T148-R35	0/30

CLEARWATER

Description	Count
NWNE S12-T144-R38	0/30
NESE S07-T145-R38	2/30
SWSW S08-T145-R38	14/30
NENW S19-T145-R38	0/30

CLEARWATER

Description	Count
SESW S19-T145-R38	0/30
SENE S30-T145-R38	0/30
NWSW S30-T145-R38	0/30
NWSE S02-145-R39	0/30
NENW S07-145-R39	0/30

HUBBARD

Description	Count
SESE S06-T139-R32	3/30
SWSW S09-T139-R32	1/30
NWNW S10-T139-R32	0/32
NWNW S11-T139-R32	0/30
SWSW S11 T139-R32	0/30
NWNE S15-T139-R32	1/30
SENE S17-T139-R32	0/30
NWNW S18-T139-R32	0/30
SWSW S28-T139-R32	0/30
SWSW S19-T139-R33	0/30
SESE S25-T139-R33	0/30
SWNW S19-T139-R35	1/30
SESW S26-T139-R35	1/30
SWSW S35-T139-R35	0/30
SWSW S02-T139-R36	0/32

HUBBARD

Description	Count
SWSW S14-T139-R36	0/30
NESE S15-T139-R36	0/30
NENE S22-T139-R36	0/30
NWSW S22-T139-R36	1/30
NWSW S23-T139-R36	0/30
SENE S24-T139-R36	1/30
SWSW S23-T140-R32	0/30
SWSW S26-T140-R32	0/30
SESE S30-T140-R32	0/30
NWNW S34-T140-R32	6/30
NWNW S36-T140-R32	1/30
NWSE S22-T140-R33	0/30
SENW S25-T140-R33	0/30
SWSE S25-T140-R33	0/30
SENW S27-T140-R33	0/30
NENE S05-T140-R36	0/30
SWSW S35-T140-R36	0/30
SESW S27-T141-R36	0/30
NWNW S35-T141-R36	0/30
SESE S19-T142-R35	0/30
NWNW S30-T142-R35	0/30
NWNW S25-T142-R36	0/30
NWNW S03-T143-R34	8/30
NWNE S08-T143-R34	7/30
SWSE S08-T143-R34	16/30
SESW S09-T143-R34	2/30
NENE S09-T143-R34	4/30
SWSW S10-T143-R34	4/30
NENE S16-T143-R34	1/30
NWNE S32-T143-R34	7/30
SENE S03-T144-R34	1/30

HUBBARD

Description	Count
SESW S04-T144-R34	1/30
NESE S10-T144-R34	7/30
SWSE S20-T144-R34	4/30
SWSE S22-T144-R34	1/30
SWSE S27-T144-R34	2/30
NWSE S29-T144-R34	6/30
NWSW S01-T145-R34	1/30
NENW S04-T145-R34	2/30
SESE S22-T145-R34	1/30
NWSW S24-T145-R34	4/30
SWSE S27-T145-R34	4/30
SESE S33-T145-R34	0/30
NWNE S34-T145-R34	8/30
NWSW S35-T145-R34	7/30
SESE S04-T145-R35	1/30
SWSW S16-T145-R35	0/30
SESW S36-T146-R34	0/30
NWSE S05-T146-R35	0/30
NESW S21-T146-R35	1/30
SWSE S21-T146-R35	0/30
SWSW S23-T146-R35	1/30
SENW S33-T146-R35	0/30

ROSEAU

SENE S02-T158-R33	0/30
SWNW S07-T159-R34	0/30
SESW S12-T159-R34	0/30
NENW S15-T159-R34	0/30
NESE S02-T159-R35	0/30
SENE S04-T159-R35	0/30
NENE S07-T159-R35	0/30

ROSEAU

Description	Count
NWNE S08-T159-R35	0/30
NENE S06-T159-R37	0/30
SESE S08-T159-R37	0/30
SENE S07-T160-R37	0/30
SWSW S08-T160-R37	0/30
NENW S19-T160-R37	0/30
NESW S29-T161-R35	0/30

ROSEAU

Description	Count
NESE S25-T161-R36	0/30
SENE S27-T161-R36	0/30
NESE S30-T161-R36	0/30
NENE S20-T161-R37	0/30
NWSE S25-T161-R37	0/30
NWSE S26-T161-R37	0/30
NESE S33-T161-R37	0/30
SESW S34-T161-R37	0/30

EGG MASS SURVEY

This survey was based on sampling 4 trees of different crown classes per sampling location. The sample unit was 18 inches of needle-bearing surface on a branch from the mid crown of each tree. The count represents the total number of egg masses found on the 4 trees. An average of 1 egg mass (4 total for the plot) predicts a potential for noticeable defoliation the following growing season.

BECKER

Description	Count
SWNW S02-T139-R36	0
NESE S15-T139-R36	0
SWNW S22-T139-R36	1
NENW S23-T139-R36	0
NENE S34-T141-R36	0

HUBBARD

Description	Count
SWSW S01-T139-R32	0
SWSW S06-T139-R32	0
NESE S09-T139-R32	0
SWSW S10-T139-R32	0
SWSW S11-T139-R32	0

HUBBARD

Description	Count
SWSW S12-T139-R32	0
NENW S30-T139-R32	0
NENE S24-T139-R33	0
SWSW S35-T139-R35	0
NWNW S35-T139-R35	0
SWSW S23-T140-R32	0
SWSW S23-T140-R32	0
NENE S24-T140-R32	0
SWSW S26-T140-R32	0
NENE S33-T140-R32	0
NWNE S34-T140-R32	0

HUBBARD

Description	Count
SWSW S35-T140-R32	0
NWNE S35-T140-R33	0
SENE S04-T143-R34	0
NWNW S08-T143-R34	0
SESW S09-T143-R34	0
NENE S09-T143-R34	0
SWSW S10-T143-R34	0
NENE S15-T143-R34	0
SWSE S02-T143-R35	0
SWNE S14-T143-R35	0
SESE S22-T144-R34	0
SWSE S35-T144-R34	**2**
SESE S11-T145-R34	0
SESE S22-T145-R34	0
NWSW S24-T145-R34	0
SESE S33-T145-R34	0

HUBBARD

Description	Count
SWSE S04-T145-R35	0
NWNW S12-T145-R35	0

BELTRAMI

NWSW S22-T146-R35	0
NENW S26-T146-R35	0
SESE S04-T147-R34	0
NWNW S14-T147-R34	0
NENE S14-T147-R34	0
NESE S26-T147-R34	0
SENE S35-T147-R34	0
NENE S01-T147-R35	0
SENW S02-T147-R35	**1**
SESW S11-T148-R35	0
SWSW S28-T148-R35	0

REGION 3

JACK PINE BUDWORM IN REGION 3 1991					
CNTY	LEGAL	DATE	BUDWORM PHNOLGY	JACK PINE PHNOLGY	REMARKS
Pine	S6 T44 R19	6-11	6-7th instar 2-4 larvae/ 15" branch	Ave. 80% of needles clipped	Severe browning on trees with staminate cones
		7-18	JPBW moths caught in PTM trap		
	S25 T45 R20	6-11	6-7th instar 2-3 larvae/ 15" branch	Ave. 60% of new needles clipped	Browning of crowns; larvae also feeding in male cone clusters
		6-18		Heavy defoliation	
		7-2	2% larvae, 80% moths and 18% pupae		Moths galore
		7-11	Moth flight is over		
	S26 T45 R20	6-11	6-7th instar 4 larvae/ branch	No browning	Feeding in male cone clusters
	S13 T45 R20	6-11	6-7th instar 0.25 larvae /branch	No browning	Feeding in male cone clusters

CNTY	LEGAL	DATE	BUDWORM PHNOLGY	JACK PINE PHNOLGY	REMARKS
	S36 T45 R20	6-11	6-7th instar	Ave. 60% defoliation with heavy browning	Many larvae still in male cones
		6-18	40% pupated	Most chewed shoots surviving	
	S1 T44 R20	6-18	40% pupated	Most chewed shoots surviving	
		7-18	JPBW moths caught in PTM trap		
	S24 T45 R20	6-26	Predominant-ly pupae, few moths		
	S30 T45 R19	7-18	JPBW moths caught in PTM traps		
Crow Wing	S9 T136 R27	6-5	Larvae 1/4-7/16" ; mostly in male cone clusters: 1 larva in ten 15" branch samples		
	S10 T136 R27	6-5	None		

CNTY	LEGAL	DATE	BUDWORM PHNOLGY	JACK PINE PHNOLGY	REMARKS
	S24 T136 R27	6-5	Larvae 1/2" 1 larva in 4 15" samples		
	S35 T137 R29	6-5	None		
	S24 T134 R29	6-5	5-6th instar 3 larvae found plus 1 dead one		
	S8 T133 R28	6-5	Larvae 1/2- 5/8" 2 larvae		
	S28 T134 R28	6-11	1 pupa found		
	S11 T136 R27	7-22	JPBW moths caught in PTM trap		
Cass	S28 T136 R32 S25 S15 T138 R32	6-12	None		
	S15 S27 T138 R32	7-12	JPBW moths caught in PTM traps		
Wa- dena	S25 T136 R33	6-12	None		

CNTY	LEGAL	DATE	BUDWORM PHNOLGY	JACK PINE PHNOLGY	REMARKS
	S2 S10 S15 T138 R33	7-12	JPBW moths caught in PTM traps		

PINE TUSSOCK MOTH

REGION 3

Pine Tussock Moth Pheromone Trapping 1991						
Trap #	Cnty	Location	Date placed	Date checked	Number of male moths	Total # moths
1	Pine	SWSE 18-45-19	6-26	7-11	2	35
				7-18	8	
				7-30	15	
				8-13	10	
2	Pine	NESE 13-45-20	6-26	7-11	4	46
				7-18	11	
				7-30	18	
				8-13	13	
3	Pine	SWSE 25-45-20	6-26	7-11	6	33
				7-18	9	
				7-30	16	
				8-13	2	
4	Pine	SESW 30-45-19	6-26	7-11	5	34
				7-18	4	
				7-30	11	
				8-13	14	

Trap #	Cnty	Location	Date placed	Date checked	Number of male moths	Total # Moths
5	Pine	SENW 30-45-19	6-26	7-11	2	19
				7-18	7	
				7-30	5	
				8-13	5	
6	Pine	SWNW 6-44-19	6-26	7-11	5	29
				7-18	7	
				7-30	7	
				8-13	10	
7	Pine	SWNE 6-44-19	6-26	7-11	2	48
				7-18	10	
				7-30	20	
				8-13	16	
8	Pine	NESE 25-45-20	6-27	7-11	1	40
				7-18	12	
				7-30	22	
				8-13	5	
9	Pine	NESW 35-45-20	6-27	7-11	1	26
				7-18	8	
				7-30	15	
				8-13	2	
10	Pine	NWNW 1-44-20	6-27	7-11	6	47
				7-18	10	
				7-30	25	
				8-13	6	

Trap #	Cnty	Location	Date placed	Date Checked	Number of male moths	Total # Moths
11	Pine	NENE 26-45-20	6-27	7-11	0	25
				7-18	8	
				7-30	12	
				8-13	5	
12	Cass	SESW 27-138-32	6-28	7-12	10	35
				7-22	3	
				8-1	16	
				8-14	6	
				8-27	0	
13	Cass	SESE 15-138-32	6-28	7-12	11	47
				7-22	12	
				8-1	12	
				8-14	12	
				8-27	0	
14	Wadena	SWSW 2-138-33	6-28	7-12	16	39
				7-22	5	
				8-1	7	
				8-14	9	
				8-27	2	
15	Wadena	SWNW 10-138-33	6-28	7-12	5	20
				7-22	4	
				8-1	3	
				8-14	8	
				8-27	0	

Trap #	County	Location	Date placed	Date checked	Number of male moths	Total # moths
16	Wadena	SWNE 15-138-33	6-28	7-12	3	15
				7-22	2	
				8-1	8	
				8-14	2	
				8-27	0	
17	Crow Wing	NESW 9-136-27	6-28	7-8	8	40
				7-22	5	
				8-1	19	
				8-14	4	
				8-27	4	
18	Crow Wing	NESW 10-136-27	6-28	7-8	4	12
				7-22	6	
				8-1	null	
				8-14	0	
				8-27	2	
19	Crow Wing	NWSW 11-136-27	6-28	7-8	9	43
				7-22	6	
				8-1	16	
				8-14	8	
				8-27	4	

Trap #	County	Location	Date placed	Date checked	Number of male moths	Total # moths
20	Crow Wing	SWSW 11-136-27	6-28	7-8	8	47
				7-22	12	
				8-1	16	
				8-14	8	
				8-27	3	

JACK PINE SAWFLIES

REGION 3

JACK PINE SAWFLIES IN REGION 3 1991					
Cnty	Legal	Date	Sawfly phenology	Jack pine phenology	Remarks
Crow Wing	S10-136-27	6-5	Larvae 5/8" long		
	S28-134-28	6-12	Larvae 3/4" long, nearly 100% are finished with feeding for season	100% defoliation of jack pines noted	
	S4-134-29	6-14	All in cocoons	Several 10-15' pines 100% stripped of old needles	
	S9-136-27	7-8	Larvae 1/2 - 3/4" long		? N. maurus
Pine	S6-44-19	6-11	Larvae 3/8" long		Many colonies observed.
	S13-45-20	6-11	Larvae 1/4" long		
	S25-45-20	6-11	Larvae 3/8" long		
		7-2			Many colonies observed.
		7-11	Larvae have pupated	Heavy defoliation, but shoots are not dead.	
	S36-45-20	6-18	Larvae 5/8" long		
	S12-45-20	6-26	Larvae 5/8 - 7/8" long	Trees not noticeably defoliated.	
Cass	S36-138-32	6-13	Found no larvae	Heavy feeding damage.	
Wa-dena	S9-138-33	6-13	Found 1 colony Larvae 1/4" long		

SPRUCE BUDWORM

REGION 2

Pheromone trapping in Cook County. Results follow:

GRAND MARAIS DISTRICT

		Avg # Moths/Trap
Jackson Lake Road	S12-T63N-R4E	139
Jackson Lake Plantation	S35-T64N-R4E	468
Devilfish Lake	S32-T64N-R3E	142

Egg mass surveys were conducted in and around white spruce plantations being considered for spraying. On each egg mass plot 3 branches (15 inches long) were clipped from the mid-crown from each of 3 dominant or co-dominant balsam fir trees. Egg mass plots were located in balsam fir trees along the edges of the plantations or in the plantations using overstory balsam firs. Expected defoliation in 1992 is based on the average number of egg masses per branch as follows:

Expected defoliation	Avg. # of eggmasses/branch
None to light	0-0.1
Moderate	0.1-1.7
Heavy	1.8+

RESULTS

PLANTATION # 426-25 Acres - 62
S34-T64N-R4E Planted 1974

Plot Number	Avg. # of eggmasses/branch
1	4
2	2.7
3	3.1
4	4.8

Plantation average = 3.7 eggmasses per branch. **Heavy defoliation** is expected.

PLANTATIONS # 337-25 and 337-25A Acres - 77
S28&34-T64N-4E Planted 1970&71

Plot number	Avg. # of eggmasses/branch
1	1
2	2.4
3	0.8
4	1.3
5	2.5
6	0.5

Plantation average = 1.6 eggmasses per branch. **Moderate defoliation** expected.

PLANTATION # 445-25 Acres - 94
S2-T63N-R4E and S35-T64N-R4E Planted 1975&76

Plot Number	Avg. # of eggmasses/branch
1	1.0
2	2.3
3	0.4
4	0.8
5	1.0

Plantation average = 1.1 eggmasses per branch. **Moderate defoliation** expected.

PLANTATION # 356-26 Acres - 17
S11-T63N-R1E Planted 1971

Plot Number	Avg. # of eggmasses/branch
1	2.5
2	1.3
3	0.4

Plantation average = 1.4 eggmasses per branch. **Moderate defoliation** expected.

PLANTATION # 355-25 Acres - 31
S14&15-T63N-R1E Planted 1971

Plot Number	Avg. # of eggmasses/branch
1	0.0
2	2.6
3	2.3
4	1.3

Plantation average = 1.58 eggmasses per branch. **Moderate defoliation** is expected.

FOREST TENT CATERPILLAR

REGION 2

FOREST TENT CATERPILLAR EGG MASS SURVEY RESULTS

LOCATION	AVG DBH	AVG NO. OF EM	PREDICT DEFOL	ACTUAL DEFOL
Itasca Co. S14-T56N-R23W	3.5	1	LIGHT	
ST LOUIS CO. S21-T57N-R21W KELLY LAKE	2.5	8	HEAVY	LIGHT
ST LOUIS C0. S30-T60N-R20W EAST OF SIDE LK	3.4	13.3	HEAVY	HEAVY
ST LOUIS CO. S33-T59N-R19W N OF BUHL	3.2	6	MODERATE	LIGHT
ST LOUIS CO. S30-T56N-R16W COTTON S.O.	3.0	4.6	MODERATE	LIGHT
LAKE CO. S19-T52N-R11W KNIFE RIVER	3.6	0.3	LIGHT	
LAKE CO. S19-T54N-R10W N OF TWO HARBORS	2.8	0.3	LIGHT	LIGHT
LAKE CO. S25-T57N-R11W SULLIVAN LAKE	2.8	0	NONE	
ST LOUIS CO. S34-T57N-R13W CADOTTE LAKE	2.9	3.3	LIGHT	

LOCATION	AVG DBH	AVG NO. OF EM	PREDICT DEFOL	ACTUAL DEFOL
ST LOUIS CO. S2-T50N-R19W	3.9	2.6	LIGHT	LIGHT
ST LOUIS CO. S2-T50N-R18W BROOKSTON	4.3	1.3	LIGHT	LIGHT
ST LOUIS CO. S5-T50N-R16W JCT 2&194	5.0	2.6	LIGHT	LIGHT
ST LOUIS CO. S36-T51N-R15W DULUTH AIRPORT	4.1	4.3	LIGHT	
ST LOUIS CO. S32-T51N-R13W	3.5	3.0	LIGHT	
ST LOUIS CO. S16-T53N-R13W	3.6	2	LIGHT	
ST LOUIS CO. S29-R49N-15W ELDE CORNER	2.5	2.6	LIGHT	
ITASCA CO. S34-T59N-R24W LINK LAKE	4.1	4.6	LIGHT	
ITASCA CO. S14-T56N-R25W N OF GRAND RAPIDS	2.8	3.3	LIGHT	LIGHT
ST LOUIS CO. S18-T51N-R20W S OF FLOODWOOD	3.2	8	HEAVY	
CARLTON CO. S31-T49N-R19W E OF CROMWELL	3.0	0	NONE	

LOCATION	AVG DBH	AVG NO. OF EM	PREDICT DEFOL	ACTUAL DEFOL
ST LOUIS CO. S1-T61N-R16W TOWER	3.6	0	NONE	
ST LOUIS CO. S31-T64N-R12W N OF ELY	3.3	0.3	LIGHT	LIGHT
ST LOUIS CO. S2-T65N-R15W E OF JEANETTE LK	3.6	0	NONE	NONE
ST LOUIS CO. S32-T66N-R17W BUYCK	3.0	0	NONE	
ST LOUIS CO. S9-T69N-R20W	3.3	0	NONE	
ST LOUIS CO. S15-T63N-R20W W OF GHEEN CORNER	3.0	0	NONE	LIGHT

REGION 3

FOREST TENT CATERPILLAR EGGMASS SURVEY PREDICTIONS FOR 1991 SEASON			
County	Legal description	Average # of egg masses	Predicted defoliation (Based on tree DBH and # egg masses)
Chisago	S28-34-21	0	0
Todd	S21-130-35	0	0
	S23-127-33	0.33	Light
Morrison	S18-132-29	0	0
	S25-321-30	0	0
Carlton	S26-47-17	1.0	Light
Kanabec	S16-41-22	0	0
Pine	S16-43-19	0	0
	S36-42-20	0	0
	S18-44-21	0	0
Wadena	S1-138-34	0	0
	S10-138-34	0	0
Aitkin	S14-44-23	0	0
	S9-44-22	0	0
	S16-52-23	0.33	Light
	S7-52-24	1.33	Light
	S16-46-27	0	0
Itasca	S11-53-23	1.66	Light
Crow Wing	S27-44-28	0	0

County	Legal description	Average # of egg masses	Predicted defoliation (Based on tree DBH and # of egg masses)
Crow Wing	S25-136-27	0	0
	S16-135-28	0	0
	S2-137-25	0	0
	S14-47-28	0	0
	S9-46-29	0.33	Light
	S5-136-27	0.33	Light
	S36-46-30	0.33	Light
Cass	S7-134-29	0	0
	S33-139-31	5.0	Moderate
	S7-140-31	3.33	Light
	S9-139-30	1.67	Light
	S1-141-29	2.33	Light
	S17-140-31	4.6	Light
	S22-139-29	3.3	Light
	S21-142-25	0	0
	S5-141-30	7.3	Moderate
	S35-138-29	0	0
	S24-139-28	0.33	Light
	S26-134-30	0	0
	S15-139-26	0	0
	S34-140-26	0	0

1991 PUBLICATIONS

✔ MANAGEMENT OF PINE BARK BEETLES
IN THE URBAN FOREST

✔ OAK MORTALITY
GUIDELINES FOR MANAGEMENT
TRANSITION YEARS

✔ BIRCH LEAF MINER

✔ FIREWOOD

✔ WINTER INJURY

MANAGEMENT OF PINE BARK BEETLES IN THE URBAN FOREST

The DNR-Division of Forestry suggests that you follow a few simple guidelines to help prevent bark beetle attack and buildup. The strategies all deal with destroying the location where bark beetles reproduce, the inner bark of stems and branches. Sanitation is the most important activity you can do to prevent bark beetle buildup. It is the basis for the success of all the other strategies.

SANITATION

There are two approaches that can be used. The first approach is to clean up all the slash, logs, bent over pines, snapped off trees, etc. prior to June 10th. Essentially, this kills the developing bark beetle larvae and thus prevents the first generation of bark beetles from emerging. See Section A. The second approach is to monitor the slash and other material for the presence of bark beetles and then destroy **only** the infested materials before the beetles finish developing. Monitoring and pine material destruction can be done in May, June, July and August. See Section B.

Section A. Dispose of all storm damaged pine material = stems, branches, stumps, broken off trees, bent over trees; basically any part of a wounded tree that has bark on it and is greater than 2 inches in diameter.

a. Peel off the bark. It's OK to keep the wood.
b. Burn the slash and wood or at least enough to char and destroy the bark.
c. Bury the slash and wood at a designated landfill.
d. Chip the slash and wood. Chips can remain on the site.
e. Use as firewood, but you MUST cover the pile with a heavy tarp from May 15 to Sept. 1. Remember to hold down the tarp edges with sand or soil.
f. Insecticides are not very effective, we don't recommend that you use them.

Section B. Fresh pine materials become infested by bark beetles during the growing season. Usually the first generation of beetles reproduces in pine slash and the subsequent generation(s) seeks out wounded or weak live trees. To determine if your pine materials are infested, obtain a pamphlet depicting bark beetle infestations from your local DNR-Forestry

Office. Disposal and destruction of infested materials should follow one of the steps outlined in Section A. Timing is critical. You want to destroy the developing beetles before they emerge as adults.

TREE CARE

Take especially good care of your remaining trees during the growing season.

a. If rainfall is less than 1 inch per week, provide it.
b. Delay fertilizing your trees for at least one year.
c. Delay pruning, thinning or otherwise wounding your pines this year with the exception of pruning out broken branches and tops.

Plant replacement trees. Contact the County Extension or Forestry Office for species suggestions and the latest information on planting methods.

PHEROMONE TRAPPING

One of the techniques being used to control bark beetles is a plastic, funnel trap baited with a pheromone, synthetic bark beetle attractant. It is a new technology that shows great promise. The traps are used to draw in large numbers of beetles, thus protecting nearby standing pines. There are no pesticides in the traps; the beetles die from starvation, dehydration or being eaten by predators. To be most effective, baited traps should be in place by May 1st. They need to be rebaited again in early June. It may be effective this year to trap the beetles emerging in early June, so these traps should be in place by June 1. Use 4-6 traps per acre (104 feet apart). This will cost approximately $200 per acre. Since this is a new technology there is no guarantee that they will prevent new tree mortality. The Minnesota representative for Phero-Tech is Steve Kunde of Steve Kunde Co. Inc., telephone = 612-488-7093.

TRAP TREES

If pheromone trapping is too expensive, trap trees may be a good alternative. Trap trees are recently felled pines that draw the attack of bark beetles to themselves rather than to the standing pines. Bark beetles start to reproduce in them, but the trees are destroyed before the bark beetles mature. Trap trees need to be disposed of or treated 3 - 4 weeks after they are cut. See Section A. This method is a good option for you if (1) you

can cut live trees during the summer and dispose of them, and, (2) you follow the trap tree guidelines to the letter. Timing is critical. If timing is ignored, trap trees actually build up the beetle population and you've got a more serious problem. To obtain trap tree procedures, contact your local DNR Forestry Office.

Share this information with your neighbors, your pines will benefit from their activities, too. Any action will have a greater effect if **everyone** takes some action.

For more information or a free pamphlet on pine bark beetles, please contact your local Forestry Office. Moose Lake Forestry = 485-4474.

OAK MORTALITY

* GUIDELINES FOR MANAGEMENT: TRANSITION YEARS *

August 1991

Oak mortality caused by a combination of drought stress, defoliation by forest tent caterpillar, girdling by the twolined chestnut borer, and root damage by *Armillaria* root rot has been at epidemic proportions throughout Minnesota since 1989. Mortality peaked during 1989 in southern Minnesota and during 1990 in northern Minnesota. Management guidelines to help reduce additional oak mortality were developed during September, 1990 to be used for the winter of 1990-91 and the growing season of 1991.

Precipitation and temperatures have returned to more normal patterns, but this does not mean that oak mortality will end. Two-lined chestnut borer and *Armillaria* root rot are still present, oak root systems are damaged, and trees' energy reserves have not rebounded to pre-drought levels. Therefore, **CAUTION** should still be your guide. It is unknown how long two-lined chestnut borer populations will remain high and what impact *Armillaria* root rot will have. Favorable weather patterns and no stand disturbances are the two ingredients for stand recovery. The more years given to stand recovery, the better the chance for increasing oak survival.

Oak mortality may have peaked during 1990, but it is still continuing. Since **CAUTION** should be your guide during these transition years from peak oak mortality to full recovery, the management decision making process should begin with an oak mortality survey. Stands being considered for some management action should be inspected before fall leaf coloration begins since oak mortality from the two-lined chestnut borer becomes evident during August. If any oaks are showing crowns with wilting and browning leaves that have occurred just this growing season, two-lined chestnut borer is still present, active, and able to cause tree mortality in that stand. (In oak wilt areas, make sure the wilting leaves are not due to oak wilt disease.) Stands with 1991 mortality should not be disturbed during the winter of 1991-92 and during the growing season of 1992.

RECOMMENDED MANAGEMENT PRACTICES

1. Product quality of the oak resource has not deteriorated and landowner objectives do not dictate an immediate harvest . . . . . **DELAY HARVESTING**

1'. Product quality has deteriorated and/or landowner objectives require an immediate harvest **2**

2. Stand will be clearcut or the entire oak component will be cut . . . . . **HARVEST**

2'. Stand will be partially cut and oak residuals will be left **3**

3. No oak mortality occurring during 1991 . . . . . **HARVEST**

3'. Oak mortality occurring during 1991 . . . . . **DELAY HARVESTING**

If the decision is made to do a partial harvest in an oak stand, continue to use the following from the 1990 guidelines:

✔ Oaks should be marked during the leaf on period. It is important to differentiate between dead or dying oaks and oaks that are alive and showing little or no dieback.

✔ Any management operation initiated should only take place during the period when the ground is frozen to minimize damage to the root systems.

✔ The term "light thinning" should rule your actions. Keep stand stocking close to the A or 100% stocking level. This will range from 115 sq. ft. of basal area for an average tree diameter of 10 inches to nearly 130 sq. ft. for average diameter of 15 inches. (See page 29, in Managers Handbook for Oaks in the North Central States.)

✔ If the stand is opened up and the drought conditions return in the next few years, chances are good that additional mortality will occur. Will the stand have enough volume to do a second salvage (or clearcut) if it is further damaged?

OAKS IN YARDS

Guidelines for managing shade and ornamental oak mortality remain the same as in 1990. Remember, two-lined chestnut borer larvae will not be found in oaks killed prior to the 1991 growing season. Only the galleries remain as evidence of past attacks. Moving and storing oak firewood from trees killed prior to 1991 does not pose any danger of spreading the two-lined chestnut borer infestation.

➜ Remove oaks which are dead and have at least 50% dieback this winter. Twolined chestnut borer will overwinter in trees killed and damaged this year. Complete removal of infested trees and disposal of infested logs and branches should be done by May 1. Infested firewood should be covered with a heavy plastic tarp with the edges buried with soil if the wood is not used by May 1. Keep the pile covered until July 15.

➜ Remove and dispose of declining oaks by July 15 if the trees do not leaf out, the leaves show signs of being sparse and small, or the leaves turn brown in June and early July.

➜ Avoid oak firewood killed in 1991 unless it has been debarked or can be kept covered with a heavy plastic tarp from May 1 to July 15. Bringing more infested wood into an area will only compound the problem.

➜ Control defoliators before 40% of the foliage is lost. Develop spray plans using Bt during the winter of 1991/92 if forest tent caterpillar defoliation is expected.

➜ Water healthy and declining oaks on a regular basis during the growing season. Make sure the trees get at least 1&1/2 inches of water per week. Water so that the entire root system receives this amount of moisture, and water so that the 1&1/2 inches comes all at once. Remember, the absorbing roots are at the dripline and beyond.

Birch Leaf Miner

The birch leaf miner, *Fenusa pusilla*, is a periodic pest of forest and ornamental birches. It mainly affects paper birch, *Betula papyrifera*, but is also known to attack most other birches such as grey birch, *Betula populifolia*, river birch, *Betula nigra*, and the non-native European white birch, *Betula pendula*. Since its introduction into Connecticut in 1923, this insect has spread over much of the range of birch in the United States and Canada.

Biology

There are several species of birch leaf miner in Minnesota. The most common of these is *Fenusa pusilla*. It normally has two generations per year, but three generations are common during warm summers.

First generation adults are active in May. They are sawflies and are about the size, shape, and color of blackflies. They are commonly found on expanding birch leaves in May in most areas of the state. Males are rare and mating is not required to produce offspring. The female lays eggs singly into slits cut into the leaves. This creates a small yellow spot on the leaf about the size of a large grain of sand where the egg was deposited. The larvae hatch in about seven days. They are very small and feed on the inside of the leaf consuming the chlorophyll bearing cells, leaving the upper and lower leaf surfaces intact, creating a leaf mine.

After the first week of feeding, the leaf mine is oval and has a powdery-green appearance. As the leaf mine continues to develop, it becomes an irregular blotch shape and turns a straw-brown. Three or four larvae can completely destroy a leaf, but 8-10 larvae per leaf are not uncommon. The dead, brown leaves commonly hang on the tree for several weeks before falling off.

The mature larva drops from the foliage and spins a cocoon in the soil. If the season is favorable, the adults will emerge from their cocoons and repeat the attack cycle. Birch leaf miners forming cocoons after mid-July will remain in the soil as cocoons until the following spring.

Another common species is the ambermarked leaf miner, *Profenusa thomsonii*. Its leaf mines look the same as *Fenusa*. The larvae of the ambermarked leaf miner lack black spots on the underside whereas the birch leaf miner has a series of black spots on the underside. The ambermarked leaf miner has only one generation per year in the spring. Birch trees affected by this insect normally refoliate in June. Control of the ambermarked leaf miner is effective, but uncommon since the damage is usually observed too late to initiate effective control action. If attack is heavy and repeated over several years, chemical control may be indicated. In these cases, control must be undertaken early, before the attack becomes obvious.

Damage

Birch leaf miners normally cause less than 40% defoliation, but can completely defoliate a tree. Healthy birch trees can suffer as much as 60% defoliation without a loss of vitality, but, if trees are stressed by other factors, a moderate attack from birch leaf miner could be detrimental. This could cause a serious decline in tree vigor if the tree is repeatedly attacked. By itself, light or infrequent defoliation is little more than an aesthetic nuisance. A frequently defoliated birch tree that is already weakened by other causes may become susceptible to attack by the bronze birch borer, *Agrilus anxius*. This borer can be quite aggressive in weakened and heavily defoliated trees and usually kills the tree over a period of years. Both these insects are common in forest and urban settings.

Cultural Control

In general, a healthy birch tree can tolerate a substantial attack by leaf miners without serious damage. To keep your birch tree healthy, we suggest the following actions. **One**, water your trees during dry periods. Water the tree each week that rainfall does not equal or exceed 1.5" from May through July. Continue watering from August until the ground freezes so that the tree receives no less than the average monthly precipitation from all sources. Even in normal years, trees will benefit from watering during the growing season. **Two**, keep a 4-6" thick mulch around the base of the tree for at least 3' (6' or more on the sunny side of the tree is better). The roots of birch are not tolerant of hot summer sun or competition with grass. **Three**, put your tree on a regular program of fertilization if a soil test shows the soil to be lacking in chemical elements. Unnecessary fertilization may harm the tree and contribute to groundwater contamination.

Chemical Control

In most situations, chemical control of birch leaf miner is only warranted where ornamental trees are involved. To be most effective, chemical sprays should be applied in the spring before the damage has occurred. The objective of any control program is to prevent damage to the tree, not to kill insects. Applications to dead, brown leaves is not effective.

A wide variety of effective materials are registered for use against birch leaf miner. Products containing either carbaryl (Sevin*) or malathion (Malathion*) are excellent contact insecticides that will kill the adults during oviposition. Once the eggs have been laid or hatched a product containing a systemic insecticide such as acephate (Orthene*) or dimethoate (Cygon*) is needed to kill the larvae. The systemic insecticides are more effective than contact insecticides because they have the added advantage of moving throughout the tree protecting areas not reached by the spray. Treatment of very large trees may require professional application by arborists who have high pressure spray equipment or specialized soil-injection equipment.

Always read and follow the directions on the pesticide label. It is illegal and dangerous to use a pesticide in a manner inconsistent with the label directions. Systemic insecticides, in particular, are easily absorbed through the skin. Always wear rubber gloves, a long sleeve shirt, and eye protection when working with acephate or dimethoate insecticides.

* Use of common trade names is included only to assist the reader. Their usage does not imply a recommendation of specific products by the State of Minnesota or the Department of Natural Resources. Your local garden supply store should be able to help in finding registered insecticides.

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Division of Forestry

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recycled paper

Firewood and Tree Pests

Firewood cut from fresh trees or trees recently infested by insects and disease can contribute to the spread of pests to nearby healthy trees. While a great many pests can breed or survive in firewood piles, the problem is critical with oak wilt, dutch elm disease, and two lined chestnut borer. In most cases, the insect or disease overwinters in the sheltered environment of the wood pile, emerges the following spring, and infests nearby trees.

Many local communities have firewood ordinances. Check with your local community before storing firewood on your property. If your community has no ordinance relating to firewood to guide your actions, undertake the following to protect your trees. Treating the firewood to destroy the insect or disease habitat will eliminate the chances that the firewood will contribute to the pest population in your neighborhood. Treat the firewood by:

(1) removing the bark while the log is still green, or
(2) cut the tree into firewood lengths and air stack it so that both ends of the firewood piece show from the stack. Cover the pile with a heavy plastic (4-6 mil) tarp from April 15 until July 1 taking care to bury the edges of the tarp with soil.

Oaks that died from oak wilt within the past year should not be moved, in any form, including firewood, into areas where oak wilt is not found. Covered or uncovered, moving oak wilt infected material into uninfected areas is very dangerous.

Fresh, Green Logs

Fresh green logs pose a special hazard even if the tree was healthy when it was cut down. In these cases, the fresh log may become a breeding ground for pests of living trees once they exit the firewood. The pine bark beetle commonly breeds in fresh logs and then moves to nearby trees after breeding in the inner bark of the firewood.

Fresh, green firewood can be treated using the same methods as for diseased material. If the trees can be felled, cut to length, and stacked in August or September, it is possible that the pile need not be covered the following spring. This is because the wood may have dried too much to permit the pests from breeding in the bark. Covering the pile is always the better treatment, but can sometimes be avoided depending on the tree and pests in your area. Contact your local forester for further advice if you do not plan on covering the pile the following spring.

Old, Dead Trees

Most pests will only use firewood logs once. Once the logs have dried out or have been used by the pest, they no longer pose future problems for your living trees. Old trees with the bark falling off no longer provide habitat for the pest.

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Winterizing Trees and Shrubs

Winter can be hard on your trees and shrubs, but a few simple procedures can reduce winter damage or eliminate it completely. Many people think that Minnesota's cold winters are the main killer, but the mid-winter thaw, bright sunny days, and an early spring are more likely to damage your plants. Non-native ornamentals are commonly damaged, but damage to native species can also occur.

Watering

Keep trees and shrubs watered until the ground is frozen. Tree roots remain active until the ground freezes. This is well after the first frosts and leaf fall. Water when weekly rainfall does not equal or exceed .5" from early September until the ground freezes. Do not over water, but make sure that the tree has about 2" of moisture from all sources, rainfall and irrigation, during September and October (4" total).

Watering is particularly important for evergreens such as cedar, pine, and spruce. Evergreen species use water during the time hardwood species are leafless in the spring and fall. Dry soil during these times exposes the trees to desiccation and may limit photosynthesis. Dry soils also permit cold temperatures to penetrate the soil better. These colder soils can cause direct injury to roots.

Mulching

Keep a thick mulch (4-6") around the base of trees. The distance out from the trunk varies with the size of the tree, but keep in mind that the mulch will provide an insulating barrier for the root system. This will help prevent cold injury and frost penetration during the winter, heat injury during the summer, and help prevent mower damage. Mulch also helps conserve soil moisture.

Mulch materials vary widely. Wood and bark chips are commonly available and provide good insulation. Straw and leaves are sometimes used as a temporary mulch, but extra care must be taken to keep them from blowing away in the wind.

Ideally, the mulch should extend out from the stem one and a half times the distance from the stem to the edge of the leafy crown. If this is impractical, mulch as much as you can. Mice commonly burrow under the mulch during the winter so be sure to place a barrier around the base of the tree to prevent mice from eating the tree's bark. Quarter inch hardware cloth is excellent for this purpose.

Tree Wrap

Tree wrap can be effectively used to protect young ornamentals from sunscald. Sun scald is caused by the sun warming up the south side of the trunk during the winter or early spring causing it to break dormancy and begin to grow. When the temperature drops again, these active tissues may freeze and die creating a dead strip on the south side of the tree. Tree wraps can reduce this injury by reflecting the sun and maintaining dormancy, particularly on young, smooth barked trees. To be effective, tree wraps should be light colored (white would be excellent) and spiral wrapped so that several layers of wrap provide some insulation. ALWAYS REMOVE THE TREE WRAP IN THE SPRING AT THE TIME OF BUD BREAK. Stop using tree wrap when the bark becomes furrowed or scaly.

The habitual use of tree wrap to protect certain species indicates that the tree or shrub is marginally hardy and is near the edge of its useful range as an ornamental. Consider replacing these specimens and avoid planting marginally hardy varieties in the future.

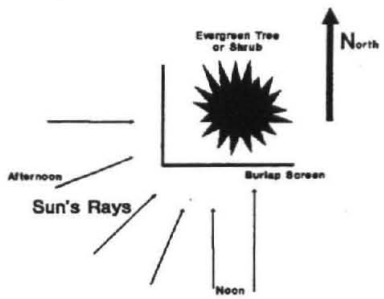
Species and Cultivar Selection

When developing your landscape, carefully consider where you plant species that are at the northern limits of their range. For example, some varieties of cedar may do better in the north-side shade of the house where they are protected from the winter sun and remain dormant. Again, avoid species known to be marginally hardy or at the northern edge of their range.

Energy conservation efforts are aided when conifers are planted on the north side of a building to block winter winds. Hardwoods are an excellent choice on the south and west exposures where they can block the summer sun, but permit the passage of the winter sun. If sensitive species are included in your plan, plant them in protected locations such as on the lee side of a windbreak or home.

Shade

Provide shade for new plantings of evergreens. Small evergreens can be effectively protected from winter sun and warm spring winds by providing a sun screen on the south and west sides of the tree. Even hardy, native species can benefit from this protection for a few years after planting. Three stakes and a piece of burlap can be very effective in providing winter protection. This barrier can be removed in the spring once the snow melts and the ground begins to thaw.



Things To Avoid

Fertilizing. Do not fertilize your tree after the first week in August. Fertilizing late in the growing season will encourage young, succulent growth at a time your plants need to be going dormant. Never fertilize with high nitrogen fertilizer, but use a balanced fertilizer applied in late spring or early summer once the leaves have formed.

Salt and Other De-icing Materials. Salt and de-icing materials leech into the soil and can seriously injure the roots of your plants. Avoid using these materials near trees and shrubs. Use sand on slippery spots.

Deicing trees. Heavy snow and ice can damage trees by bending and breaking them. Remove the snow from the tree before it becomes ice. If a heavy snowfall overloads the tree, carefully knock off the snow, working up from the bottom of the tree to the top.

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